ISACM 2007

FIRST CONFERENCE OF
INTERNATIONAL SOCIETY FOR THE ADVANCEMENT OF
CLINICAL MAGNETOENCEPHALOGRAPHY

PROGRAM AND ABSTRACTS

AUGUST 27-30, 2007
HOTEL TAIKANSO, MATSUSHIMA, JAPAN
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Dear Colleagues and Friends,

We are pleased to announce the foundation of our new society, the International Society for the Advancement of Clinical Magnetoencephalography (ISACM) with an initial membership of more than one hundred from all over the world. On behalf of the Executive Committee, we would like to invite you to Matsushima to attend the first conference of the ISACM to be held on August 27-30, 2007.

Magnetoencephalography (MEG) provides unique information about spontaneous or evoked brain activity that may not be detected by electroencephalography or other imaging techniques. However, clinical MEG has not been widely practiced. One reason for this may be the absence of a scientific society with the mission to advance its clinical applications. Instead, clinical MEG reporting has occupied a very small part in meetings of much broader societies, such as those of clinical neurophysiology, neuroimaging, or biomagnetism. In addition to close collaboration with such societies, we think that there is a need for a specialized society to discuss the unique issues involved in the clinical application of MEG.

The scientific program of the first meeting of the new society, ISACM 2007, will summarize all the established fields of clinical MEG, highlight the cutting edge technologies, and try to identify new applications. The business program of ISACM 2007 will establish an action-plan to solve social issues for the expanded use of clinical MEG. Finally, the social program of ISACM 2007 will provide opportunities to discover the culture and traditions of Matsushima.

We hope that the first ISACM meeting will encourage established, new, and potential clinical users of MEG in their endeavors and we look forward to welcoming all to Matsushima.

Sincerely,

Co-chairs of ISACM 2007

Nobukazu Nakasato
President, ISACM

Andrew C. Papanicalaou
Vice President, ISACM

Kyousuke Kamada
Treasurer, ISACM
ORGANIZATION

ISACM 2007

CONFERENCE ORGANIZERS

Co-Chairs:
Nobukazu Nakasato, Sendai
Andrew C. Papanicolaou, Houston
Kyousuke Kamada, Tokyo

Local Organizing Committee:
Nobukazu Nakasato, Sendai (Chair)
Satoru Fujiwara, Sendai (Co-Chair)
Teiji Tominaga, Sendai (Co-Chair)
Masaki Iwasaki, Sendai
Akitake Kanno, Sendai
Shinya Kuriki, Sapporo
Satoru Ohtomo, Sendai
Mitsunori Omori, Sendai
Isamu Ozaki, Aomori
Nobuhito Saito, Tokyo
Katsuhiko Sato, Sendai
Masuro Shintani, Chiba
Toshiki Yoshimine, Osaka

Conference Secretariat:
/o Masatoshi Amino
Kintetsu International Express
Sendai Event & Convention Office
1-7-20, Chuo, Aoba-ku, Sendai 980-0021, Japan
Tel: +81-22-222-4141
Fax: +81-22-221-6188
Email: iscam@kohnan-sendai.or.jp
URL: http://www.knt.co.jp/kokusai/index.html

ISACM Inc.

EXECUTIVE COMMITTEE
(September 2006 - August 2008)

Nobukazu Nakasato (Sendai)
President

Andrew C. Papanicolaou (Houston)
Vice President; President-Elect; and Chair,
Annual Meeting Committee and Membership/
Nominating/Election Committee

Timothy P. Roberts (Philadelphia)
Secretary and Chair, Bylaws Committee

Kyousuke Kamada (Tokyo)
Treasurer, and Chair, Reimbursement
Committee

Gregory Barkley (Detroit)
Chair, Reimbursement Committee for North
America

Hermann Stefan (Erlangen)
Chair, Reimbursement Committee for Europe

Isao Hashimoto (Tokyo)
Chair, Practice Standards and Guidelines
Committee

Gian L. Romani (Chieti)
Chair, Training Committee

Hiroshi Otsubo (Toronto)
Chair, Clinical Research Committee

John Ebersole (Chicago)
Chair, Physician/Patient Education Committee
## PROGRAM AT A GLANCE

### August 27, Monday

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>07:30</td>
<td>Conference Venue: Hotel Taikanso</td>
</tr>
<tr>
<td>08:00</td>
<td>Executive Committee Meeting &amp; Banquet: Hotel Ichinobo (Hotel Ichinobo)</td>
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<tr>
<td>09:00-16:00</td>
<td>Executive Committee Meeting (Hotel Ichinobo)</td>
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<tr>
<td>Registration</td>
<td>16:00-</td>
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<tr>
<td>16:30</td>
<td>Satellite Seminar hosted by Yokogawa Electronic Inc. (Hotel Taikanso)</td>
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<tr>
<td>17:00</td>
<td>“MEG: Clinical Application and Research Task (in Japanese)”</td>
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<tr>
<td>17:30</td>
<td>16:20-18:20</td>
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<tr>
<td>18:00</td>
<td>&amp; Aperitifs 18:30</td>
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### August 28, Tuesday

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>08:00</td>
<td>Poster Set Up / Registration</td>
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<tr>
<td>08:30</td>
<td>Opening 08:25</td>
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<tr>
<td>09:00</td>
<td>Symposium I: Temporal Lobe Epilepsy (Chair: Ebersole &amp; Lin) 08:30-10:00</td>
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<tr>
<td>10:00</td>
<td>Break (20 min.)</td>
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<tr>
<td>11:00</td>
<td>Symposium II: Language (Chair: Papanicolaou &amp; Bowyer) 10:20-11:50</td>
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<tr>
<td>12:00</td>
<td>Break (20 min.)</td>
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<tr>
<td>12:30</td>
<td>Luncheon Seminar I (Mäkelä) 12:10-13:00</td>
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<tr>
<td>13:00</td>
<td>Poster Session A 13:00-13:30</td>
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<tr>
<td>13:30</td>
<td>Poster Session B 13:30-14:00</td>
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<tr>
<td>14:00</td>
<td>Free Discussion 14:00-14:30</td>
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<tr>
<td>14:30</td>
<td>Symposium III: Psychiatry Disease (Chair: Ishii &amp; Holroyd) 14:30-16:00</td>
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<tr>
<td>15:00</td>
<td>Break (20 min.)</td>
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<tr>
<td>15:30</td>
<td>Symposium IV: Pathological Oscillation (Chair: Hashimoto &amp; Maestú) 16:20-17:50</td>
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<tr>
<td>16:00</td>
<td>Sunset View &amp; Aperitifs: 18:00-</td>
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<tr>
<td>16:30</td>
<td>Welcome Reception: 19:00-</td>
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<tr>
<td>17:00</td>
<td>Total Eclipse of the Moon 18:52-20:22</td>
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### August 29, Wednesday

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<th>Time</th>
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<tbody>
<tr>
<td>08:00</td>
<td>Registration</td>
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<tr>
<td>08:30</td>
<td>Symposium V: Sensorimotor Cortex (Chair: Romani &amp; Nagamine) 08:30-10:00</td>
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<tr>
<td>10:00</td>
<td>Break (20 min.)</td>
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<tr>
<td>10:30</td>
<td>Symposium VI: Stroke (Chair: Barkley &amp; Kamada) 10:20-11:50</td>
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<tr>
<td>11:00</td>
<td>Break (20 min.)</td>
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<tr>
<td>12:00</td>
<td>Luncheon Seminar II (Maestú) 12:10-13:00</td>
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<tr>
<td>12:30</td>
<td>Town Meeting (Chair: Nakasato) Report of ISACM Subcommittees; Welcome to Biomag 2008 &amp; ISACM 2009; and &quot;Get-Together Photo&quot; 13:00-15:00</td>
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<tr>
<td>13:00</td>
<td>Transportation to Cruise Pier</td>
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<tr>
<td>16:30</td>
<td>Sunset Bay Cruise with Aperitifs hosted by Elekta K. K. 16:30-19:30</td>
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<tr>
<td></td>
<td>Free Evening</td>
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### August 30, Thursday

<table>
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<tr>
<th>Time</th>
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<tbody>
<tr>
<td>08:00</td>
<td>Registration</td>
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<tr>
<td>09:00</td>
<td>Symposium VII: Pediatric Epilepsy (Chair: Otsubo &amp; Wheless) 08:30-10:00</td>
</tr>
<tr>
<td>10:00</td>
<td>Break (20 min.)</td>
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<tr>
<td>10:30</td>
<td>Symposium VIII: Developmental Disorders (Chair: Roberts &amp; Lewine) 10:20-11:50</td>
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<tr>
<td>12:00</td>
<td>Luncheon Seminar III (Bast) 12:10-13:00</td>
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<tr>
<td>13:00</td>
<td>Poster Session C 13:00-13:30</td>
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<td>14:00</td>
<td>Poster Session D 13:30-14:00</td>
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<tr>
<td>14:30</td>
<td>Free Discussion 14:00-14:30</td>
</tr>
<tr>
<td>15:00</td>
<td>Symposium IX: Epilepsy Surgery (Chair: Stefan &amp; Castillo) 14:30-16:00</td>
</tr>
<tr>
<td>16:00</td>
<td>Transportation from Hotel Taikanso to Hotel Ichinobo</td>
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<tr>
<td>18:30</td>
<td>Welcome Drink 18:30-18:30</td>
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<tr>
<td>19:30</td>
<td>Japanese Culture Events (The Shibata Brothers) 19:30</td>
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<tr>
<td>20:00</td>
<td>Banquet: 20:00-</td>
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CONGRESS INFORMATION

Registration

Registration Desk (1F)

Operation Hours:  
August 27, Monday, 16:00-18:00  
August 28, Tuesday, 07:30-18:00  
August 29, Wednesday, 08:00-15:00  
August 30, Thursday, 08:00-18:00

Name Badge

Delegates are required to wear the name badges throughout the entire conference.

Registration Fee Includes

Regular registration fee includes
- Admission to all scientific sessions and the Town Meeting.  
- Welcome reception on August 28th.  
- Sunset Bay Cruise and Aperitifs on August 29th.  
- Banquet on August 30th (On-line pre-registration, or “On-site” pre-registration by 13:00 August 29th).

Accompanying Person’s registration fee includes
- Welcome reception on August 28th.  
- Sunset Bay Cruise and Aperitifs on August 29th.  
- Banquet on August 30th (On-line pre-registration, or “On-site” pre-registration by 13:00 August 29th).

Secretariat

During the Meeting

Please visit the Registration Desk (1F). Secretary Room “Godai” (2F) is for private use only.

After the Meeting

Conference Secretariat ISACM 2007  
c/o Masatoshi Amino (Mr.)  
Kintetsu International Express  
Sendai Event & Convention Office  
1-7-20, Chuo, Aoba-ku, Sendai 980-0021, Japan  
Tel: +81-22-222-4141, Fax: +81-22-221-6188  
Email: iscam@kohnan-sendai.or.jp, URL: http://www.knt.co.jp/kokusai/index.html

Audio or Video Recording

NO AUDIO OR VIDEO RECORDING, please, during oral sessions (symposia and luncheon seminars), unless permitted officially by the conference.

Message Board

You may post or check messages on the conference “Message Board” in front of “Registration Desk”.
Instruction for Authors

Poster Presentation

All the posters will be displayed in the main hall, Fuji, throughout the conference from Tuesday (28th) morning to Thursday (30th) evening. Poster board surface measures 120 cm wide by 180 cm high. Your poster number will be displayed on top left edge of the board.

Each author is required to attend in front of the poster according to the following session groups:

- Poster Session A: 13:00-13:30, August 28, Tuesday
- Poster Session B: 13:30-14:00, August 28, Tuesday
- Poster Session C: 13:00-13:30, August 30, Thursday
- Poster Session D: 13:30-14:00, August 30, Thursday
- Free Discussion: 14:00-14:30, August 28 and 30.

Oral Presentation

Your PC-based presentation with your own laptop computer is strongly recommended. Slide, overhead, or VCR projectors will NOT be accepted. If you include movie files, please use PowerPoint animation, but NOT MediaPlayer files. Ensure “mini D-sub 15 pins” is equipped in your PC, or bring an appropriate converter with you. Please also bring an A/C adaptor (100 V, 50 Hz). Please hand your PC over the operator desk located just behind the podium at least 30 minutes before your presentation. On the podium, a display monitor, a keyboard and a remote mouse will be provided for your operation.

If you bring your data in a CD-R or a USB flash memory stick, we accept only PowerPoint files in Windows (PowerPoint2003 / XP 2003) or in Macintosh (PowerPoint 2004 / OS X). Please use your own laptop computer if you include movie files. Our PC Media Center is located in front of the main conference hall (Fuji). We recommend your early check-in at least 30 minutes before your symposium starts.
PROGRAM

Monday, August 27

09:00 - 16:00 Executive Committee Meeting (Hotel Ichinobo)

16:20 Satellite Seminar (Hotel Taikanso)
“MEG: Clinical Application and Research Task (in Japanese)”
Hosted by Yokogawa Electronic Inc.

Tuesday, August 28

07:30 Registration, Poster Set Up
08:25 Opening

08:30 Symposium I: Temporal Lobe Epilepsy
Chair: John S. Ebersole (USA) and Yung-Yang Lin (Taiwan)

S-01-1 MEG spike propagation analysis in evaluating neocortical temporal lobe epilepsy
John S. Ebersole (USA)

S-01-2 Neuromagnetic responses to auditory deviants in temporal lobe epilepsy
Yung-Yang Lin (Taiwan)

S-01-3 MEG investigations in patients with superior temporal lobe epilepsy
Gabriela Scheler (Spain)

S-01-4 Magnetoencephalographic spike mapping, MRI and post-operative seizure outcome in temporal lobe epilepsy
Masaki Iwasaki (Japan)

10:00 Break (20 min.)

10:20 Symposium II: Language
Chair: Andrew C. Papanicolaou (USA) and Susan M. Bowyer (USA)

S-02-1 Side of the stimulated ear influences the hemispheric balance in coding tonal stimuli
Hsiang-Yu Yu (Taiwan)

S-02-2 MEG coherence imaging applications for language mapping
Susan M. Bowyer (USA)

S-02-3 Noninvasive evaluation of language dominance and localization using synthetic aperture magnetometry: comparison with the Wada test and stimulation mapping
Masayuki Hirata (Japan)

S-02-4 Enhancing the objectivity of presurgical language mapping
Andrew C. Papanicolaou (USA)

11:50 Break (20 min.)

12:10 Luncheon Seminar I
Chair: Teiji Tominaga (Japan)

L-01 New ways to utilize MEG in studies of neurological patients
Jyrki P. Mäkelä (Finland)
13:00 Author’s attendance, Poster Session A (see Titles)
13:30 Author’s attendance, Poster Session B (see Titles)
14:00 Poster Session (Free)
14:30 Symposium III: Psychiatry Disease
   Chair: Ryohei Ishii (Japan) and Tom Holroyd (USA)
   S-03-1 MEG methods in neuropsychiatric research
      Tom Holroyd (USA)
   S-03-2 Recent advances in clinical application of MEG in psychiatric disorders
      Ryouhei Ishii (Japan)
   S-03-3 Phonetic magnetic mismatch field (MMF) as a functional probe for glutamatergic/synaptic dysfunction
      in schizophrenia
      Kiyoto Kasai (Japan)
   S-03-4 Source localization of MEG slow activity in chronic interictal psychosis of epilepsy
      Leonides Canuet (Japan)
16:00 Break (20 min.)
16:20 Symposium IV: Pathological Oscillation
   Chair: Isao Hashimoto (Japan) and Fernando Maestú (Spain)
   S-04-1 Introduction to pathological oscillations: from HFOs to DC-shift
      Isao Hashimoto (Japan)
   S-04-2 Ictal onset 20-40 Hz activity recorded by MEG
      Ritva A Paetau (Finland)
   S-04-3 Spontaneous MEG activity in Alzheimer’s disease and mild cognitive impairment
      Fernando Maestú (Spain)
   S-04-4 MEG coherence imaging of low frequencies: applications for stroke and migraine
      Susan M. Bowyer (USA)
17:50 Break
18:00 Sunset View, Aperitifs, Welcome Reception and Total Eclipse of the Moon
   18:11 Partial Moon Eclipse, Rise
   18:14 Sun Set
   18:49 Total Moon Eclipse, Start
   20:21 Total Moon Eclipse, End
   21:25 Partial Moon Eclipse, End
Wednesday, August 29

08:00  Registration

08:30  **Symposium V: Sensorimotor Cortex**  
*Chair: Gian-Luca Romani (Italy) and Takashi Nagamine (Japan)*  

S-05-1  Movement related changes of rhythmic and slow activities revealed by magnetoencephalographic studies  
*Takashi Nagamine (Japan)*

S-05-2  Plasticity in sensory and motor cortex after unilateral lesions of the pyramidal tract  
*Christoph Braun (Germany)*

S-05-3  MEG in the study of sensorimotor cortex: clinical issues  
*Gian-Luca Romani (Italy)*

S-05-4  Sensorimotor cortical functions in chronic pain  
*Nina Forss (Finland)*

10:00  **Break (20 min.)**

10:20  **Symposium VI: Stroke**  
*Chair: Gregory Barkley and Kyousuke Kamada*

S-06-1  Enhanced late components of AEFs associated with the temporal lobe lesions  
*Kyousuke Kamada (Japan)*

S-06-2  Alteration of motor magnetic field in patients with cerebral vascular occlusive disease  
*Satoru Oshino (Japan)*

S-06-3  Temporo-parietal theta activity detected by MEG correlates with cerebral hemodynamic impairment  
*Satoru Ohtomo (Japan)*

S-06-4  MEG coherence imaging applications for stroke  
*Gregory Barkley (USA)*

11:50  **Break (20 min.)**

12:10  **Luncheon Seminar II**  
*Chair: Nobuhito Saito (Japan)*  

L-02  **Memory Studies in Alzheimer's Disease and Mild Cognitive Impairment: a clinical role of MEG**  
*Fernando Maestú (Spain)*

13:00  **Town Meeting**  
*Chair: Nobukazu Nakasato (President, ISACM)*

TM-1  Subcommittees Report  
*Timothy P. L. Roberts (Secretary, ISACM)*

TM-2  Welcome Message to ISACM 2009  
*Andrew C. Papanicolaou (President-Elect, ISACM)*

TM-3  Welcome Message to Biomag 2008, Sapporo  
*Shinya Kuriki (Chair, Biomag 2008)*

Get-Together Photo

16:30  **Sunset Bay Cruise with Aperitifs**  
“Viva ISACM! We are on the same boat” Hosted by Elekta K.K.

19:30  Free Evening
Thursday, August 30

08:00  Registration

08:30  Symposium VII: Pediatric Epilepsy
Chair: Hiroshi Otsubo (Canada) and James W. Wheless (USA)
S-07-1 Graded magnetoencephalographic analysis for patients with epilepsy: for the global application for every patient with epilepsy
Hideaki Shiraishi (Japan)
S-07-2 Magnetoencephalography of childhood benign epileptic syndromes: Panayiotopoulos syndrome and Gastaut type idiopathic childhood occipital epilepsy
Jun Tohyama (Japan)
S-07-3 Pediatric epilepsy surgery and magnetoencephalography
James W. Wheless (USA)
S-07-4 Magnetoencephalography and intracranial video EEG in pediatric intractable epilepsy
Hiroshi Otsubo (Canada)

10:00  Break (20 min.)

10:20  Symposium VIII: Developmental Disorders
Chair: Timothy P. L. Roberts (USA) and Jeffrey D. Lewine (USA)
S-08-1 On the relationships between epileptiform activity and neurocognitive development
Jeffrey D. Lewine (USA)
S-08-2 The attentional effect in attention deficit hyperactivity disorder (ADHD) by magnetoencephalography (MEG)
Alejandra Carboni (Spain)
S-08-3 Anatomical asymmetry of the M100 source in typically developing children and children with autism spectrum disorders
Gwen Schmidt (USA)
S-08-4 Electrophysiological endophenotypes of language impairment in autism: MEG studies
Timothy P. L. Roberts (USA)

11:50  Break (20 min.)

12:10  Luncheon Seminar III
Chair: Toshiki Yoshimine (Japan)
L-03 Combined EEG and MEG analysis in patients with malformations of cortical development
Thomas Bast (Germany)

13:00  Author’s attendance, Poster Session C (see Titles)

13:30  Author’s attendance, Poster Session D (see Titles)

14:00  Poster Session (Free)

14:30  Symposium IX: Epilepsy Surgery
Chair: Hermann Stefan (Germany) and Eduardo M. Castillo (USA)
S-09-1 Concepts of the epileptogenic zone: use of pre- and intraoperative MSI for epilepsy surgery
Hermann Stefan (Germany)
S-09-2 MEG can characterize the epileptogenicity in neocortical epilepsy: evidence from postoperative long-term seizure outcome
Makoto Oishi (Japan)
S-09-3  Does MEG/EEG focality predict good postoperative seizure control after epilepsy surgery?
Stefan Rampp (Germany)

S-09-4  Can MEG substitute some of the invasive procedures in epilepsy surgery? - Evidences from outcome studies
Eduardo M. Castillo (USA)

16:00  Break (20 min.)

16:20  Symposium X: Presurgical Mapping and Neuronavigation
Chair: Kyousuke Kamada (Japan) and Amami Kato (Japan)

S-10-1  Cerebral motor control in patients with brain tumors around the central sulcus studied with synthetic aperture magnetometry
Amami Kato (Japan)

S-10-2  Presurgical mapping and neuronavigation: experience of Seoul National University Hospital
Chun Kee Chung (Korea)

S-10-3  Spatiotemporal signal space separation (tSSS) in clinical practice: a review of 17 cases
Michael Funke (USA)

S-10-4  Visualization of the language network on tractography by the co-utilization of MEG and fMRI
Kyousuke Kamada (Japan)

17:50  Break/Transportation to Hotel Ichinobo

18:30  Welcome Drink (Hotel Ichinobo)

19:40  Japanese Culture Events
(The Shibata Brothers)

20:30  Banquet

Transportation to Hotels

***
Poster Session A
Author’s attendance: 13:00-13:30, August 28, Tuesday

Epilepsy-I

P-A-01 Application of beamformer algorithm to MEG spontaneous recordings in epilepsy patients with vagal nerve stimulators
Douglas F. Rose (USA)

P-A-02 Clinical, MEG and neuroimaging analyses of patients with malignant rolandic-sylvian epilepsy in children
Kazuhiro Haginoya (Japan)

P-A-03 Comparison of interictal MEG with electrocorticogram and intraoperative hippocampal electrogram in temporal lobe epilepsy
Naohiro Tsuyuguchi (Japan)

P-A-04 Effects of total intravenous anesthesia by propofol on MEG for pediatric patients with intractable epilepsy
Ayataka Fujimoto (Canada)

P-A-05 Magnetoencephalographic (MEG) analysis in two epilepsy patients with negative myoclonus
Hideji Hattori (Japan)

P-A-06 MEG-directed epilepsy surgery for patients with congenital bilateral/unilateral perisylvian syndrome
Hiroatsu Murakami (Japan)

P-A-07 Neuromagnetic localization of spike sources in perilesional, contralateral mirror, and ipsilateral remote areas in patients with cavernoma
Kazutaka Jin (Japan)

P-A-08 Preoperative evaluation using gradient magnetic-field topography (GMFT) for magnetoencephalography in patients with neocortical epilepsy
Hiroshi Shirozu (Japan)

P-A-09 Presurgical identification of epileptogenic area using multimodal evaluation: MEG, iomazenil SPECT and FDG-PET
Hirotomo Ninomiya (Japan)

P-A-10 Profound inspection of interictal epileptiform discharges: application of synthetic aperture magnetometry to detect epileptogenic zone in children with epilepsy
Hisako Fujiwara (USA)

P-A-11 Successful screening of neocortical epilepsy using routine MEG recordings
Pauly Ossenblok (Netherlands)

P-A-12 Systematic approach of SAMg2 and clustering analysis localizing multiple foci in patients with tuberous sclerosis complex
Katsumi Imai (Canada)

P-A-13 Clinical value of magnetoencephalography (MEG) in localization of epileptogenic areas: report of 39 cases
Guoming Luan (China)

P-A-14 Development of contralateral spike focus over years in a patient with cavernoma and medically intractable epilepsy
Yosuke Kakisaka (Japan)
Poster Session B
Author’s attendance: 13:30-14:00, August 28, Tuesday

Brain Lesions

P-B-01 The effects of neuromuscular electrical stimulation in hemiplegia using magnetoencephalography
Kei Nakagawa (Japan)

P-B-02 Combined use of functional MRI, magnetoencephalography and near-infrared spectroscopy for
identification of language dominance
Takahiro Ota (Japan)

P-B-03 Gradual recovery from dyslexia and related serial magnetoencephalographic changes in the
lexicosemantic centers after resection of a mesial temporal astrocytoma: case report
Taichi Kin (Japan)

P-B-04 Presurgical mapping of paediatric motor function and structure using magnetoencephalography (MEG)
and diffusion tensor imaging (DTI)
William Gaetz (Canada)

P-B-05 Somatosensory functional assessment in frontal lobe tumors by somatosensory evoked field
Daisuke Tsuchiya (Japan)

P-B-06 VEF study in two surgical cases of occipital lobe lesions
Tohru Ohta (Japan)

P-B-07 Local oscillatory changes related to the pattern reversal visual stimulation in the patients with a lesion
in the optic pathway
Naoki Tani (Japan)

Psychiatry and Special Diseases

P-B-08 Clinical application of MEG: establishing an objective quantitation of curative effects for cervical
spondylotic myelopathy
Naoki Higashiyama (Japan)

P-B-09 Ictal and interictal magnetoencephalogram of paroxysmal kinesigenic choreoathetosis
Keiko Yanagihara (Japan)

P-B-10 MEG activities during a memory task in patients with early Alzheimer’s disease
Ryu Kurimoto (Japan)

P-B-11 Sensory recognition mechanism in the congenital insensitivity to pain and anhidrosis patient: a
magnetoencephalography study
Nobuyuki Matsuura (Japan)

P-B-12 Abnormal neural oscillatory activity to speech sounds in schizophrenia: an MEG study
Shogo Hirano (Japan)

P-B-13 Dysfunction of visuomotor integration in patients with temporomandibular disorders
Yoshiyuki Shibukawa (Japan)

P-B-14 Pathological high frequency oscillations in writer’s cramp
Zoe F. Cimatti (France)
Poster Session C
Author’s attendance: 13:00-13:30, August 30, Thursday

Epilepsy-II

P-C-01 Effects of generalized epileptic discharges on MEG coherences of frontal area in idiopathic generalized epilepsy
Kotaro Sakurai (Japan)

P-C-02 Analysis of interictal high frequency oscillations using gradient magnetic-field topography on magnetoencephalography in patients with intractable epilepsy
Koji Iida (Japan)

P-C-03 Spectral statistics of correlation matrices from MEG signals in epilepsy
Maribel Pulgarin-Montoya (United Kingdom)

P-C-04 Identifying epileptic abnormality with volumetrically reconstructed default mode of brain
Jing Xiang (USA)

P-C-05 Localization of ictal onset neuromagnetic oscillations using a spatiotemporal beamformer
Ismail S Mohamed (Canada)

P-C-06 Integration of dipole localization with MEG for intraoperative neuronavigation system
Yohei Yokoyama (Japan)

P-C-07 Value of interictal MEG spikes in guiding placement of ECoG electrodes
Eun Young Kim (Korea)

P-C-08 Magnetoencephalographic analyses for interictal rhythmic spikes in patients with symptomatic localization related epilepsy induced by circumscribed cortical lesions using time-frequency analysis
Keitaro Sueda (Japan)

Stroke

P-C-09 Characteristics of neuronal activation in the primary sensorimotor cortex under chronic ischemia and its change through surgical intervention
Takenori Akiyama (Japan)

P-C-10 Analysis of magnetoencephalography for cerebral ischemia using spatial filter techniques: comparison of adaptive beamformer with sLORETA
Naohiro Tsuyuguchi (Japan)

P-C-11 Magnetoencephalography as a prognostic tool in acute monohemispheric stroke
Franca Tecchio (Italy)

P-C-12 Altered visual processing in migraine patients with persistent visual aura
Wei-Ta Chen (Taiwan)

Accuracy Control

P-C-13 Proposition of an MEG phantom as the evaluation standard
Gen Uehara (Japan)
Poster Session D
Author's attendance: 13:30-14:00, August 30, Thursday

Language and Higher Brain Function

P-D-01 Modulation of auditory evoked responses to chords unfolded in musical sequence
Asuka Otsuka (Japan)

P-D-02 Magnetic brain activity patterns in men and women according to motivated attention concept
Cristina Saugar (Spain)

P-D-03 Eye-gaze and spatial attention: spatio-temporal localisation with MEG
Yoko Nagata (Canada)

P-D-04 Magnetoencephalographic determination of hemispheric dominance for language and language specific areas with minimum L1 norm current estimate
Kenichi Shibata (Japan)

P-D-05 Time-frequency analysis for prediction of language dominant hemisphere in Elekta-Neuromag neuromagnetometer system
Akira Hashizume (Japan)

P-D-06 Volumetric localization of language cortex with high-frequency neuromagnetic signals
Jing Xiang (USA)

Motor, Somatosensory and Pain

P-D-07 Movement related cerebral fields following forearm pronation in normal and patients with CNS disorders
Takeshi Fushimi (Japan)

P-D-08 Usefulness of spatial filter on the pain perception: an MEG study
Atsuo Yoshino (Japan)

P-D-09 Characteristics of somatosensory evoked field for tactile finger stimulation
Maaya Orii (Japan)

P-D-10 Distributions of activation on somatosensory cortex in time-delay conditions by bilateral median nerve stimulation
Atsushi Fukunaga (Japan)

P-D-11 Natural tactile stimuli for MEG experiments
Veikko Jousmaki (Finland)

P-D-12 Quantitative analysis of somatosensory evoked fields using standardized low-resolution electromagnetic tomography
Yuzo Terakawa (Japan)

P-D-13 Somatosensory evoked magnetic fields (SEFs) from buccal and tongue mucosa using piezo-driven tactile stimulation device
Yohei Tamura (Japan)

P-D-14 Somatosensory evoked magnetic fields elicited by sacral surface electrical stimulation
Mabumi Matsushita (Japan)

P-D-15 Somatosensory evoked magnetic fields following the tongue stimulation
Hitoshi Maezawa (Japan)

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L-01

New ways to utilize MEG in studies of neurological patients

Jyrki P. Mäkelä

BioMag Laboratory, Helsinki University Central Hospital, Helsinki, Finland

Artifact suppression methods of MEG signals have developed rapidly. We have used signal space separation with temporal extension (tSSS) to enhance MEG studies of neurological disorders. The data used for localization of the epileptogenic cortical areas prior to epilepsy surgery are clarified by tSSS. Moreover, combination of tSSS with the continuous localization of the head position makes ictal recordings more feasible. Stimulation artifacts have prevented MEG of patients with spinal or deep brain stimulation (DBS). After tSSS, SEFs to median nerve stimulation are detected and modeled reliably, and display modulation of sensory cortical functions by DBS. SEF sources were stronger during DBS on than off in five out of six patients. Effects of spinal stimulation on SEFs in patients with chronic neuropathic pain were smaller. Navigated transcranial magnetic stimulation (nTMS) enables a spatially accurate modification of cortical function. We have compared localization of motor cortex by nTMS with MEG localization of somatosensory and epileptogenic cortex in patients during workup for epilepsy surgery. The nTMS landmarks agree with those obtained by MEG. The accuracy of mapping by MEG and nTMS equals the data from the grid stimulation mapping, emphasizing further the possibilities of preoperative non-invasive methods.

L-02

Memory studies in Alzheimer's disease and mild cognitive impairment: a clinical role of MEG

Fernando Maestú

Department of Basic Psychology II, Faculty of Psychology, Complutense University of Madrid, Madrid, Spain

Taking advantage of the spatio-temporal resolution provided by Magnetoencephalography (MEG), a series of studies were carried out in elderly population, depression, Mild Cognitive Impairment and Alzheimer's Disease (AD) in order to prospectively determine biomagnetic profiles that may assess AD early diagnosis. All data were recorded during a modified version of the Sternberg's paradigm. In those studies in which the activity was recorded during a memory task, AD patients showed lower number of dipoles over the left parieto-temporal area beyond 400 ms, compared to normal elderly subjects. This biomagnetic pattern together with the degree of hippocampal atrophy and metabolic N-acetyl-aspartate - myo-Inositol scores predicted the Minimental State Examination (MMSE) scores in both AD and healthy elderly subjects. Furthermore, when early AD patients were compared with elderly depressives and elderly controls, the AD group showed lower number of activity sources. Finally, two further studies were carried out with Mild Cognitive Impairment (MCI) patients. MCI patients showed an increased activity of the ventral pathway in comparison to controls. This profile of activity in MCI patients could represent a reorganization of the memory networks due to the loss of effectiveness and atrophy of the medial temporal lobe. The biomagnetic profiles of those MCI patients that develop or not dementia will be described as well.
Combined EEG and MEG analysis in patients with malformations of cortical development

Thomas Bast

Department of Pediatric Neurology, University Hospital, Heidelberg, Germany

Malformations of cortical development (MCD) are a frequent cause of pharmacoresistant epilepsy. An increasing number of patients with MCD is identified by improved structural imaging and referred to presurgical evaluation. Inverse source analysis of MEG and EEG signals is a non-invasive diagnostic tool with a high temporal resolution and satisfying localization accuracy. It is applied to analyses of interictal and ictal epileptiform and physiologic, event related activities. Various studies have demonstrated the usefulness of a combination of both methods. MEG has some advantages over EEG. A lower influence of volume conduction results in a higher localization accuracy. Differences in signal-to-noise ratio lead to higher spike detection rates in MEG compared to EEG. However, MEG is almost exclusively sensitive to signals from tangential and oblique sources and mainly reflects activities from fissural or basal pyramidal cells. In contrast, EEG depicts activities from sources with variable orientations. EEG signals are dominated by activities of neurons with radial orientation located in the gyral crowns. Cortical malformations may lead to anatomical changes with abnormal gyration, thus resulting in marked differences between EEG and MEG analysis. The general recommendation of simultaneous recordings especially applies for patients with MCD.
S-01-1

MEG spike propagation analysis in evaluating neocortical temporal lobe epilepsy

John S. Ebersole, Susan M. Ebersole

Department of Neurology, University of Chicago, Chicago, USA

Consensus has it that MEG is not as useful in temporal lobe epilepsy (TLE) as in extra-temporal seizure disorders. This opinion may be correct in cases of classic mesial TLE where there are other diagnostic signs, such as mesial temporal sclerosis. Furthermore, isolated hippocampal spikes often do not result in identifiable magnetic fields. These factors are not pertinent in neocortical temporal lobe epilepsy, which in many centers is now more common than mesial TLE. The MRI is often normal; thus localization is dependent upon functional data. The most epileptogenic temporal neocortex (basal and tip) produces spikes with clear magnetic signals. Spike propagation is common, however, and MEG analysis of only the spike peak or the latency of maximal dipolarity may not reveal the spike's true cortical origin. Moving dipole or spatio-temporal dipole models should be used whenever spike magnetic fields show evidence of evolution that suggests propagation. The spatio-temporal source resolution afforded by MEG is clearly useful when evaluating neocortical TLE.

S-01-2

Neuromagnetic responses to auditory deviants in temporal lobe epilepsy

Yung-Yang Lin 1.2.3.4), Fu-Jung Hsiao 1.2)

1) Institute of Physiology, National Yang-Ming University, Taipei, Taiwan
2) Department of Medical Research and Education, Taipei Veterans General Hospital, Taipei, Taiwan
3) Department of Neurology, Taipei Veterans General Hospital, Taipei, Taiwan
4) Institute of Brain Science, National Yang-Ming University, Taipei, Taiwan

The cerebral reactivity to auditory deviants may reflect auditory discrimination and sensory memory, and has therefore received considerable interest because of its potential application value in clinical research. To explore the oscillatory correlates of cortical processing of unpredicted auditory stimuli and study whether temporal lobe epilepsy (TLE) affects automatic central auditory-change processing, we recorded neuromagnetic responses to deviant and standard sounds in healthy adults and TLE patients, and also measured the inter-trial phase locking values of single epochs by employing wavelet-based analyses. Compared with standard sound stimuli, deviants elicited an enhanced phase-locking and obvious power change for theta oscillation at 150-250 ms after stimulus onset, suggesting an important role of theta activity in auditory change detection within the temporo-frontal network. Besides, we observed longer latencies of the magnetic counterpart of mismatch negativities for patients than controls. Notably, in patients who became seizure free after removal of right temporal epileptic focus, the phase locking phenomena of deviant-evoked responses were enhanced, and even more distributed in the frontotemporal regions. Our results suggest that mesial TLE might affect auditory-change detection, and that phase-locking analysis provides a useful approach to the evaluation of the underlying cortical processing.
S-01-3

MEG investigations in patients with superior temporal lobe epilepsy

Gabriela Scheler, Marta Santiuste, Rafał Nowak, Galleon Graetz, Antonio Russi

MEG Unit, Centro Médico Teknon, Barcelona, Spain

Introduction: Fourteen patients with superior temporal lobe epilepsy were investigated in order to determine the concordance with EEG findings and possible contribution of deep brain structures.

Method: Measurements were performed with a whole-head neuromagnetometer equipped with 148 sensors (Magnes 2500, 4D Neuroimaging) and installed in a magnetically shielded room designed to reduce environmental magnetic noise. Acquisition parameters for continuous recording were set to 1-200 Hz band-pass filter and 678 Hz sampling rate. Evoked data were acquired with 1-100 Hz band-pass filter and 508.63 Hz sampling rate. Simultaneously a 10-20 EEG was recorded. Visually selected epileptiform discharges were calculated as single equivalent current dipoles and are overlaid on the patient's MR images.

Results: Interictal spike localization calculated from simultaneous MEG and EEG recordings showed source localisation in superior temporal lobe. In the nine cases classified as monofocal five showed corresponding MEG results to EEG activation, in the eight bifocal patients correspondence was seen just in three. In all as bifocal classified patients deep temporal brain structures like hippocampus were activated as well, in as monofocal classified patients just four showed deep temporal brain activation.

S-01-4

Magnetoencephalographic spike mapping, MRI and post-operative seizure outcome in temporal lobe epilepsy

Masaki Iwasaki 1), Nobukazu Nakasato 1), Hiroshi Shamoto 1), Teiji Tominaga 2), Satoru Fujiwara 1)

1) Department of Neurosurgery, Kohnan Hospital, Sendai, Japan
2) Department of Neurosurgery, Tohoku University Graduate School of Medicine, Sendai, Japan

Purpose: To find the possible predictive value of pre-operative MRI and MEG studies for post-operative seizure outcome in patients with temporal lobe epilepsy (TLE).

Methods: Patient database was reviewed for 49 consecutive patients with medically refractory TLE who underwent resective surgery of the temporal lobe at our institution. Two factors were related to post-operative seizure outcome: (MRI factor) The presence of unilateral hippocampal atrophy or epileptogenic lesion in the temporal lobe which was removed by surgery, (MEG factor) spikes predominantly localized in the unilateral anterior temporal region or in the vicinity of epileptogenic lesion.

Results: Patient subgroups which satisfied both of the two factors (n=19), only the MRI (n=15), only the MEG (n=7), and neither of them (n=8) achieved seizure freedom at a rate of 89.5%, 73.3%, 71.4%, and 37.5%, respectively.

Conclusion: When a patient is indicated for surgical treatment after comprehensive evaluation, the presence of unilateral hippocampal atrophy, or epileptogenic lesion in the temporal lobe to be removed, is associated with good post-operative outcome. However, even in the absence of such MRI findings, anterior temporal or peri-lesional MEG spikes are associated with similarly good outcome. Otherwise, surgical indication should be considered with caution.
S-02-1

Side of the stimulated ear influences the hemispheric balance in coding tonal stimuli

Hsiang-Yu Yu 1, 2), Jen-Tse Chen 1, 3), Zin-An Wu 1, 2), Tsu-Chen Yeh 1, 4), Low-Tone Ho 1, 4), Yung-Yang Lin 1, 2, 3, 5)

1) Neurologic Institute, Taipei Veterans General Hospital, Taipei, Taiwan
2) Department of Neurology, National Yang-Ming University, Taipei, Taiwan
3) Department of Neurology, Cathay General Hospital, Taipei, Taiwan
4) Department of Medical Research and Education, Taipei Veterans General Hospital, Taipei, Taiwan
5) Institute of Brain Science, National Yang-Ming University, Taipei, Taiwan

Objective: To evaluate whether the side of stimulated ear affects the hemispheric asymmetry of auditory evoked cortical activations.

Methods: Using a whole-head neuromagnetometer, we recorded neuromagnetic ~100 ms responses (N100m) in 21 healthy right-handers to 100 ms and 1 kHz tones delivered alternatively to left and right ear.

Results: Although the peak latencies of N100m were shorter in contralateral than in ipsilateral hemisphere, the difference was significant only for the left ear stimulation. Based on the relative N100m amplitudes across hemispheres, the laterality evaluation showed a rightward predominance of N100m activation to tone stimuli, but the lateralization toward the right hemisphere was more apparent by the left than by the right ear stimulation (laterality index: -0.27 versus -0.10, p=0.008). Within the right hemisphere, the N100m was 2–4 mm more posterior for left ear than for right ear stimulation.

Conclusions: The hemispheric asymmetry in auditory processing depends on the side of the stimulated ear. The more anterior localization of right N100m responses to ipsilateral than to contralateral ear stimulation suggests that there might be differential neuronal populations in the right hemisphere for processing spatially different auditory inputs.

S-02-2

MEG coherence imaging applications for language mapping

Susan M. Bowyer 1, 2, 3), John E. Moran 1), Karen M. Mason 1), Brien J. Smith 1, 2), Neetu Shukla 3), Gregory L. Barkley 1, 2), Norman Tepley 1, 3)

1) Department of Neurology, Henry Ford Hospital, Detroit, USA
2) Department of Neurology, Wayne State University, Detroit, USA
3) Department of Physics, Oakland University, Rochester, USA

Coherence is a measure of synchronization between brain regions. Synchronized activity within a neuronal network is determined by the strength of network connections. How well two or more brain regions are connected can be determined by measuring the coherence between these regions. MEG coherence imaging for localization of normal and/or abnormal language networks was investigated.

MEG data from patients with epilepsy, subjects with dyslexia, and control subjects were used for this analysis. Language tasks included Picture Naming, Verb Generation, and Syllable Matching. MEG data were analyzed using ICA to extract independent sources of brain activity, these sources were then imaged with MR-FOCUSS. FFT spectra were calculated for active sources and a coherence spectral matrix between sources was calculated (1-50 Hz).

Imaging coherence between brain regions may be used to identify the hemisphere used to support memory and language function similar to Wada testing. Regional coherence in subjects with learning disorders may indicate a change or disruption in the neural networks and thereby provide a quantitative measure of the disorder. MEG and EEG are sensitive to small changes in synchrony (coherence) within neuronal populations, but these changes do not necessarily require increased metabolism, and would be invisible in fMRI and PET recordings.
Noninvasive evaluation of language dominance and localization using synthetic aperture magnetometry: comparison with the Wada test and stimulation mapping

Masayuki Hirata 1,2), Amami Kato 3), Satoru Oshino 1), Youichi Saitoh 1), Haruhiko Kishima 1), Tetsu Goto 1), Naoki Tani 1), Takufumi Yanagisawa 1), Shiro Yorifuji 2), Toshiki Yoshimine 1)

1) Department of Neurosurgery, Osaka University Medical School, Osaka, Japan
2) Division of Functional Diagnostic Science, Osaka University Graduate School of Medicine, Osaka, Japan
3) Department of Neurosurgery, Kinki University, Osaka-Sayama, Japan

Purpose: We previously proposed a noninvasive method to determine language dominance based on the local oscillatory changes induced by silent reading (Neuroimage, 2004). The present study investigated language dominance with larger population and also language localization. The results were compared with the Wada test and stimulation mapping.

Method: One hundred and three neurosurgical patients participated in this study. Patients were instructed to read a word silently immediately after visual presentation of the word. Totally 100 words were presented. Using synthetic aperture magnetometry (SAM), local oscillatory changes were obtained as spatial distribution of Student's t statistics. Language dominance was determined by the laterality index derived from maximum t values of the left and right frontal desynchronization. Language dominance and localization were compared with the Wada test (N=64) and stimulation mapping (N=15), respectively.

Results: Language dominance by SAM was concordant with the Wada test in 51 cases (83.6%). Localization of the frontal language areas by SAM was compared with stimulation mapping in 10 cases. Estimated frontal language areas were well concordant with stimulation mapping.

Conclusion: Our method is a noninvasive alternative to the Wada test. As for language localization, our method is useful to determine the stimulation sites during invasive mapping.

Enhancing the objectivity of presurgical language mapping

Andrew C. Papanicolaou
Center for Clinical Neurosciences, The University of Texas Medical School, Houston, USA

Following a brief description of the paradigm we typically use of receptive language assessment and its validation, the following ways of enhancing the objectivity of MEG-derived maps will be discussed: (1) The development of a completely automated map constructive procedure, based on the single dipole model and its validation with several language tasks. (2) The validation of the minimum norm estimate (MNE) approach to mapping both receptive and expressive language cortex.
MEG methods in neuropsychiatric research

Tom Holroyd, Fred Carver, Richard Coppola

NIMH MEG Core Facility, National Institutes of Health, Bethesda, USA

Neuropsychiatric disorders emerge from a complex interaction of the influences of genetics and environment. These influences effect subtle changes at the cellular and the systems level leading to disturbed behavior. MEG affords a window on the dynamics of functional brain activity that allows investigation of this complex interaction. This investigation can address questions at several levels from possible sensory auditory disturbances to more complex behavioral difficulties in cognitive systems such as memory and attention. We will present examples from sensory habituation and refractory periods using event related methodology. This is particularly applicable to controversies of sensory gating in schizophrenia. For higher order systems MEG source localization and estimation methods are important for studying behavioral phenotypes. In a working memory example we will show how we can begin to dissect differences between clinical groups and how they may be related to genetic variation.

Recent advances in clinical application of MEG in psychiatric disorders

Ryohei Ishii 1), Ryu Kurimoto 1), Leonides Canuet 1), Koji Ikezawa 1), Michiyo Azechi 1), Hidetoshi Takahashi 1), Takayuki Nakahachi 1), Masao Iwase 1), Toshiki Yoshimine 2), Masatoshi Takeda 1)

1) Department of Psychiatry, Osaka University, Osaka, Japan
2) Department of Neurosurgery, Osaka University, Osaka, Japan

The accumulating results on presurgical mapping of epileptogenic areas have provided sufficient evidence suggesting that neurosurgical MEG can be considered as one of the most important clinical application of this method. Recently, an increasing number of MEG studies in psychiatry area are helping us to understand the pathophysiological mechanisms underlying psychiatric disorders. Schizophrenia, which is a chronic psychiatric syndrome often described as the worst affliction of mankind, has been explored by MEG studies, which have revealed that various cortical areas might be implicated in the dysfunctional neural network of this disorder. Auditory hallucinations are considered a key sign of schizophrenia, and remain as a serious problem for a large subgroup of patients. MEG studies addressing the neural correlates of auditory hallucinations have demonstrated a strong association of the left superior temporal cortex and these symptoms. In this work, we will review these previous MEG studies in psychiatry and introduce our recent MEG results on schizophrenia, epilepsy psychosis, dementia, and autism spectrum disorder.
S-03-3

Phonetic magnetic mismatch field (MMF) as a functional probe for glutamatergic/synaptic dysfunction in schizophrenia

Kiyoto Kasai

Department of Neuropsychiatry, The University of Tokyo, Tokyo, Japan

Patients with schizophrenia are associated with abnormalities in auditory mismatch negativity (MMN) and its magnetic counterpart, magnetic mismatch field (MMF), which is compatible with glutamatergic/synaptic dysfunction hypothesis of schizophrenia. We have extended the findings by using MMN/MMF in response to phoneme change, and showed that the effect size of the reduction was larger for phonetic MMN/MMF than tonal MMN/MMF (Kasai et al., 2002, 2003). Moreover, in patients with schizophrenia, the reduced MMF power was significantly correlated with smaller gray matter volume of planum temporale where the major generators of MMF are located (Yamasue et al., 2004). Our investigations are now moving toward establishing MMF as a useful intermediate phenotype for glutamatergic/synaptic dysfunction in schizophrenia. Data from healthy monozygotic and dizygotic twins indicate that phonetic MMF shows high heritability. Variations in metabotropic glutamate receptor 3 (GRM3) and brain derived neurotrophic factor (BDNF) genotypes interactively modulate MMF strength and hemispheric specialization in healthy men. These convergent data suggest that phonetic MMF may be a non-invasive probe for evaluating synaptic plasticity based on glutamatergic neurotransmission system in the auditory cortex in healthy individuals and in patients with schizophrenia.

S-03-4

Source localization of MEG slow activity in chronic interictal psychosis of epilepsy

Leonides Canuet, Ryouhei Ishii, Ryu Kurimoto, Koji Ikezawa, Michiyo Azeki, Masao Iwase, Masatoshi Takeda

Department of Psychiatry, Osaka University, Osaka, Japan

Little is known about the neural correlates of epilepsy psychosis. There is recent evidence suggesting that abnormalities in the temporal lobes (paralimbic regions) are implicated in the development of psychotic symptoms in epilepsy. We used MEG and synthetic aperture magnetometry (SAM) to evaluate the concordant rate in locations of slow activity sources (delta, theta) between patients with temporal lobe epilepsy (TLE) with and without psychosis. Four patients with schizophrenia-like psychosis of epilepsy (SLPE) (age 26.5 ± 7.5) and four epilepsy patients without psychosis (age 37.7 ± 8.8) were investigated. Patients with age>50, IQ<70, brain lesions, under polytherapy with antiepileptic drugs, and taking benzodiazepines or antidepressants were excluded. MEG source locations were superimposed on the patients' MRI. All patients with SLPE exhibited delta activity sources over the left temporal region. Contralateral frontal or temporal delta sources were also found in two patients. Only one patient in the TLE control group exhibited delta activity sources in the left temporal and contralateral frontal region. The other patients showed different locations such as frontal, occipital and centroparietal. Theta activity did not show consistent locations in either group. These preliminary findings suggest that delta activity sources in the left temporal region may be associated to psychopathology in epilepsy.
Introduction to pathological oscillations: from HFOs to DC-shift

Isao Hashimoto
Kanazawa Institute of Technology, Tokyo, Japan

Over the past decades, abnormal EEG rhythms have been studied extensively in patients with CNS diseases. For example, detection of EEG spikes has been the sine qua non for the diagnosis of epilepsy. However, accurate localization of the scalp recorded EEG spikes is hampered mainly due to the volume conductor properties of the skull. In contrast, MEG provides a high spatiotemporal resolution, because the skull is transparent to MEG. This unique advantage of MEG over EEG has led to intensive studies of epileptic spikes with MEG. The recent surge of interest in other abnormal brain rhythms, I believe, is prompted by the success of accurate localization of MEG spikes.

Pathological oscillations can be defined as the modulation of a specific frequency and/or amplitude in various CNS diseases and have been examined from HFOs (600 Hz) in SI, slow waves in the theta and delta ranges to cortical DC-shift. These abnormal oscillations may share in part the generation mechanisms with the normal oscillations but also have specific mechanisms for different diseases. My talk will mainly focus on HFOs in a variety of CNS diseases. It is hoped that the symposium will shed some light on the underlying pathophysiology of abnormal oscillations.

Ictal onset 20-40 Hz activity recorded by MEG

Ritva A. Paetau 1,2), Mordekhay Medvedovsky 2), Samu Taulu 3), Göran Blomstedt 4), Dana Ekstein 5), Itzhak Fried 6), Eija Gaily 1), Miri Neufeld 6), Liisa Metsähonkala 1), Jyrki P. Mäkelä 2)

1) Hospital for Children and Adolescents, Department of Child Neurology, Helsinki University Central Hospital, Helsinki, Finland
2) Biomag Laboratory, Department of Clinical Neurophysiology, HUSLAB, Helsinki University Central Hospital, Helsinki, Finland
3) Elekta Neuromag Oy, Helsinki, Finland
4) Department of Neurosurgery, Helsinki University Central Hospital, Helsinki, Finland
5) Hadassah Ein-Kerem Medical Center, Jerusalem, Israel
6) Tel-Aviv Sourasky Medical Center, Tel-Aviv, Israel

Direct cortical recordings have revealed local low-amplitude high-frequency activity at epileptic seizure onset. Their non-invasive recording is challenging, as a relatively strong signal is needed for scalp EEG and MEG. We analyzed ictal MEG data of three epilepsy patients to identify and localize fast (beta-gamma) trains at seizure onset. MEG seizures were recorded with a whole-head MEG device (Elekta Neuromag®). The data were sampled at 300 Hz or 600 Hz. To track possible head movement during epileptic events, the head position of two patients was monitored continuously using 154-166 Hz signal from four coils on the scalp. For visual analysis, the data were band-pass filtered at 0.3-90 Hz and clinical seizures were inspected. The typical ictal events of all three patients started with flattening of interictal activity, growing to visible fast oscillations within a few seconds. Oscillations at about 20-35 Hz were analyzed with equivalent current dipoles. The sources were in the premotor cortex, close to the supplementary motor cortex, and in the right occipital medial cortex, all consistent with the ictal semiology of each patient. We conclude that 30-45 Hz ictal onset activity can be recorded by MEG and, probably, represents a relatively local circuit, which helps to identify the epileptogenic region.
Spontaneous MEG activity in Alzheimer's disease and mild cognitive impairment

Fernando Maestú, Alberto Fernandez

MEG Center Dr Pérez Modrego, Complutense University of Madrid, Madrid, Spain

Patients suffering from Alzheimer's disease (AD) exhibit more activity in the conventional EEG delta and theta bands. Our investigation revealed an increase in the delta dipoles was observed in the left parietal, temporal, prefrontal and right parietal regions, whereas the theta dipoles were increased in both temporal and parietal regions. Furthermore, parietal delta dipole density of the spontaneous activity predicted cognitive decline in patients with mild cognitive impairment in a 2-year follow-up. Spectral analyses of spontaneous MEG recorded in eyes closed condition revealed slowing of the mean relative power peak from 10.5 to about 7.5 in patients with Alzheimer's disease; mean value for mild cognitive impairment was 8.5 Hz. In addition, quantitative MEG (qMEG) was used in order to investigate differences in the 2-60 Hz spectral power, between AD patients and control subjects. MEG signal analysis comprised the division of the entire 2-60 Hz spectrum in 2 Hz-width sub-bands. Using 2-4 Hz values was possible to choose a classification rule with an estimate sensitivity and specificity given by 68% and 76% respectively. When 16-28 Hz values are utilized, it is possible to obtain a better classification rule with an estimate sensitivity and specificity given by 81% and 80% respectively.

MEG coherence imaging of low frequencies: applications for stroke and migraine

Susan M. Bowyer 1,2,3), John E. Moran 1), Karen M. Mason 1), Brien J. Smith 1,2, Panos Mitsias 1,2), Brian Silver 1,2), Gregory L. Barkley 1,2), Norman Tepley 1,3)

1) Department of Neurology, Henry Ford Hospital, Detroit, USA
2) Department of Neurology, Wayne State University, Detroit, USA
3) Department of Physics, Oakland University, Rochester, USA

Imaging cortical areas of coherence can determine how well two or more brain regions are connected. Recently, in a human, we imaged areas of coherence within 72 hours of a stroke and again at 6 weeks, 4 months and 6 months. Our coherence analysis showed low frequency (1-7 Hz) signals arising from the edge of the lesion 72 hours after stroke. By 3 weeks these signals had abated near the lesion. Coherence analysis of the higher frequencies (8-100 Hz) was imaged around the lesion at 6 weeks, 4 months and again at 6 months. The extent and severity of neuronal damage assessed using MEG may correlate with the recovery. Higher frequency MEG signals may correspond to surviving neuronal circuits and synaptic connections being recruited to perform new functions whereas low frequency MEG signals may be associated with cell death and destruction.

In migraine patients, coherence was seen in the occipital regions during visual stimulation prior to drug treatment therapy. Immediately after treatment and 30 days later these coherent networks had been disrupted, and correlated with relief from headaches. Coherence imaging may provide physicians with MEG markers or factors to identify recovery-related neuronal events to determine the course of treatment for stroke and migraine.
S-05-1

Movement related changes of rhythmic and slow activities revealed by magnetoencephalographic studies

Takashi Nagamine 1), Akira Mitani 2)

1) Human Brain Research Center, Kyoto University Graduate School of Medicine, Kyoto University, Kyoto, Japan
2) Department of Occupational Therapy, School of Health Sciences Faculty of Medicine, Kyoto University, Kyoto, Japan

Movement related magnetic fields have been utilized to investigate the neural mechanisms underlying voluntary movements mainly for unilateral finger movements. Although conventional scalp EEG recordings have shown the initiation of movement related cortical potentials over the midline area around 2 to 3 s prior to the movement onset, the shift of pre-movement magnetic activity is observed from 1 s to several hundred milliseconds before the onset over the contralateral somatomotor area. This later initiation of magnetic activity compared to EEG specifically indicates the role of fissural part of the primary motor area. As for the background activity, magnetic signal of 20 Hz starts dampening around 3 s prior to movement onset over the bilateral hemispheres, which is induced for both muscle contraction and relaxation. On the other hand, this 20 Hz activity is induced after median nerve stimulation and is suppressed by various types of movements including actual movement and action observation. This suppression can be elicited even in viewing another person's movement and is affected by the direction of the hand. These alterations of rhythmic and slow activities provide information as for temporal profile of activities in the motor cortex.

S-05-2

Plasticity in sensory and motor cortex after unilateral lesions of the pyramidal tract

Christoph Braun 1), Martin Staudt 2) Christian Gerloff 3)

1) MEG-Center, Institute for Medical Psychology, Department of Pediatric Neurology, University of Tübingen, Tübingen, Germany
2) Department of Pediatric Neurology, University Hospital, Tübingen, Germany
3) Cortical Physiology Research Group, Hamburg University Medical Center, Hamburg, Germany

After unilateral lesions in the motor pathway some patients regain remarkably good motor functions. However, the brain regions and mechanisms involved in the recovery of motor functions are still not well understood. In particular, there is a controversy about the role of contralesional, intact motor cortex. Using a multi-modal approach including cortico-motor coherence analyses based on MEG and EMG measurements, TMS and fMRI, plastic changes in the motor system have been studied in two groups of patients having received their lesions either prenatally or as adults. As confirmed by TMS, cortico-motor coherence did not show any significant coherence between contralesional motor cortex and the paretic hand in adult patients. Conversely, in patients with congenital hemiparesis, the intact hemisphere appeared to control both hands. The intimate link between haptic processing and motor control in tasks requiring fine motor adjustments motivated the study of potential changes in the organization of somatosensory cortex in the group of congenital hemiparetic patients. Strikingly, unlike motor functions, no transhemispheric reorganization could be observed in the somatosensory modality. Concluding, data show that different types of reorganization exist in the motor pathway depending on the developmental stage of the patients' nervous system at the time of the lesion.
MEG in the study of sensorimotor cortex: clinical issues

Gian-Luca Romani 1,2), Stefania Della Penna 1,2), Raffaella Franciotti 1, Franca Tecchio 3,4), Vittorio Pizzella 1,2)

1) Institute of Advanced Biomedical Technologies, University of Chieti, Chieti, Italy
2) Department of Clinical Sciences and Bioimaging, University of Chieti, Chieti, Italy
3) Institute of Sciences and Technologies of Cognition, National Research Council, Rome, Italy
4) Associazione Fatebenefratelli per la Ricerca, Rome, Italy

The properties of somatosensory cortices during peripheral stimulation have been extensively investigated by MEG. Involvement of SI and SII, during execution of complex tasks in basic neuroscience studies, has been demonstrated as well. SI (and MI) has also proved to be extremely capable to reorganize its functional organization during the recovery phase after stroke. Another interesting property is the ability of SII to selectively discriminate painful vs. non-painful electrical stimulation, with a segregation of two different neuron populations elicited by different stimuli. Additionally, pain processing in higher areas as the insula and cingulum, which should be involved in the emotional aspect of pain perception, is still to be comprehensively studied. In this talk the response of the above regions to pure painful stimuli, produced by a pin electrode, with respect to non-painful electrical stimulation presented in a certain and uncertain context, will be illustrated, pointing out a characteristic behaviour of specific areas when the expectation of pain is present. A second experiment concerning an alteration of the intra-cortical connectivity of the network devoted to somatosensory representation of the thumb (ICC_T) in patients suffering by multiple sclerosis will be described as well. In these patients, ICC_T correlated significantly with lesion load.

Sensorimotor cortical functions in chronic pain

Nina Forss 1,2), Nuutti Vartiainen 1), Katariina Kallio-Laine 3), Eija Kalso 3), Erika Kirveskari 1)

1) Brain Research Unit, Helsinki University of Technology, Helsinki, Finland
2) Department of Neurology, Helsinki University Central Hospital, Helsinki, Finland
3) Department of Anesthesiology, Helsinki University Central Hospital, Helsinki, Finland

Chronic pain is a devastating disease that has a major economical impact on society. Yet the central mechanisms of chronic pain are largely unknown. We compared laser evoked fields (LEFs) of complex regional pain syndrome (CRPS) patients with the healthy subjects. In the controls, the earliest activity was generated in the bilateral SII cortices, followed by consistent activation of posterior parietal cortex (PPC). In patients, SII activation was not significantly changed compared with the controls, whereas no PPC activation was observed. Defective activation of the PPC may account for the neglect-like symptoms often described in these patients.

Signs of motor dysfunction are frequently detected in chronic pain patients suggesting close functional connections between the pain and the motor systems. We showed with 10 healthy subjects that acute pain modulates the functions of the motor cortex. Both Ad- and C-fiber stimuli elicited long-lasting attenuation of the motor cortex rhythm, indicating a prolonged activation of the motor cortex in association with acute pain. In CRPS patients, we observed significantly altered reactivity of the motor cortex to acute pain suggesting that inhibition of the motor cortex is altered in these patients.
S-06-1

Enhanced late components of AEFs associated with the temporal lobe lesions

Kyousuke Kamada 1), Takahiro Ota 1), Taichi Kin 1), Fumiya Takeuchi 2), Shinya Kuriki 2), Nobuhito Saito 1)

1) Department of Neurosurgery, The University of Tokyo, Tokyo, Japan
2) Research Institute for Electronic Science, Hokkaido University, Sapporo, Japan

We recorded auditory evoked magnetic fields (AEFs) by presenting pure tone bursts once every 4000 ms in thirteen patients with a brain lesion in or in the vicinity of the auditory cortex. AEFs on the damaged side revealed several enhanced deflections in late-latency AEFs (slow-AEFs), peaking at approximately 320 (D1), 1030 (D2) and 1600 (D3) ms post-stimulus in 10 patients. All the dipoles of slow-AEFs were concentrated in the superior temporal regions which were not involved by brain lesions. D1-, D2- and D3-dipoles were uniformly upward, downward and upward, respectively. The dipole moment varied from 12 to 122 nAm and had no consistent relationship with latency. Time-frequency analysis detected lower frequency components (lower than 5Hz) were synchronized by the auditory stimuli in the affected hemisphere. Four patients with brain tumor or hematoma demonstrated slow-AEFs diminished after removal of the lesions. Slow-SEFs might possibly become a functional indicator of the temporal lobe. This is the first report describing slow-AEFs in cases with temporal lobe lesions.

S-06-2

Alteration of motor magnetic field in patients with cerebral vascular occlusive disease

Satoru Oshino 1), Amami Kato 2), Masayuki Hirata 1), Haruhiko Kishima 1), Youichi Saitoh 1), Naoki Tani 1), Toshiyuki Fujinaka 1), Toshiki Yoshimine 1)

1) Department of Neurosurgery, Osaka University Graduate School of Medicine, Osaka, Japan
2) Department of Neurosurgery, Kinki University, Osaka-Sayama, Japan

Objective: Cerebral vascular occlusive disease is an established risk factor for ischemic stroke. However, little is known about its affection on brain function itself under such a condition. To detect possible functional alterations, we applied magnetoencephalography for these patients without motor symptoms.

Methods: Using synthetic aperture magnetoencephalometry, the spatial distribution and the degree (t-values) of desynchronization in beta band during grasping and self-paced finger tapping tasks were evaluated in 27 patients with occlusive disease (19 with the atherosclerotic lesion (AS) and 8 with non-atherosclerotic lesion) and in 8 age-matched control subjects. According to the laterality index (LI) calculated from peak t-values on ipsi- and contra-lateral hemisphere, the activation patterns were classified as contra-, bi-, and ipsi-lateral activation.

Results: The abnormal ipsi-lateral activation was observed significantly frequent in AS (13/19) during contra-lesional hand grasping. The LI during hand grasping was significantly lower in AS, whereas there was no significant difference in LI during the finger tapping task. The etiology, the higher age and the higher degree of sulcal atrophy were the 3 most significant factors for the incidence of ipsi-lateral activation.

Conclusion: Abnormal ipsi-lateral activation could suggest the presence of subclinical functional alterations in patients with atherosclerotic occlusive vascular disease.
S-06-3

Temporo-parietal theta activity detected by MEG correlates with cerebral hemodynamic impairment

Satoru Ohtomo 1), Nobukazu Nakasato 2), Hiroaki Shimizu 2), Shintarou Seki 3), Akitake Kanno 2), Teiji Tominaga 3)

1) Department of Neurosurgery, National Hospital Organization Miyagi National Hospital, Miyagi, Japan
2) Department of Neurosurgery and Tohoku Ryogo Center, Kohnan Hospital, Sendai, Japan
3) Department of Neurosurgery, Tohoku University Graduate School of Medicine, Sendai, Japan

MEG can detect temporo-parietal theta activity (TPTA) more clearly than EEG in patients with occlusive lesion of the internal carotid artery (ICA) or middle cerebral artery (MCA). The present study investigated whether TPTA is correlated with cerebral hemodynamic impairment. Fifty-six patients with ICA or MCA occlusive lesions underwent spontaneous MEG in the awake condition. Cerebral hemodynamic status was evaluated based on cerebral blood flow (CBF) and cerebrovascular reactivity (CVR) to acetazolamide measured by xenon-133 single-photon emission computed tomography. Postoperative MEG was also performed in 10 patients with TPTA who underwent vascular reconstruction surgery. TPTA was found unilaterally in the occlusive hemisphere of 13 patients and bilaterally in 1 patient with unilateral occlusive lesion. Multivariate logistic regression analyses showed the presence of TPTA was significantly correlated with hemodynamic conditions of both reduced rCBF and reduced rCVR in the MCA territory (P = 0.0009). TPTA disappeared after vascular reconstruction surgery in 7 of 10 patients. Presence of TPTA in MEG correlates with cerebral hemodynamic impairment including misery perfusion suggested by reduced rCBF and rCVR. Spontaneous MEG can be applied to the objective evaluation of ischemic conditions before and after vascular reconstruction surgery.

S-06-4

MEG coherence imaging applications for stroke

Gregory L. Barkley 1, 2), Susan M. Bowyer 1, 2, 3), John E. Moran 1), Karen M. Mason 1), Brian J. Smith 1, 2), Panayiotis D. Mitsias 1, 2), Brian Silver 1,2), Norman Teply 1, 3)

1) Department of Neurology, Henry Ford Hospital, Detroit, USA
2) Department of Neurology, Wayne State University, Detroit, USA
3) Department of Physics, Oakland University, Rochester, USA

Imaging cortical areas of high coherence is an innovative analysis method in neuroimaging. Recently, in a human, we have imaged areas of low and high coherence within 72 hours of an infarct and again at 6 weeks, 4 months, and 6 months. Our preliminary coherence analysis showed 1-7 Hz low frequency signals arising from the edge of the infarct 72 hours after infarction. By 3 weeks these signals had abated near the lesion but now can be seen in the contralateral hemisphere. Higher frequencies (8-100 Hz) did not show any coherence in the initial MEG performed within 72 hours of infarction but were imaged around the infarct at 6 weeks, 4 months, and again at 6 months. Presently there is no precise imaging tool providing evidence that drug treatments will improve neurological and functional outcomes in stroke patients. Functional imaging measurements would be important as they would provide clinicians with a tool for gauging stroke recovery and effectiveness of medical treatments. The current challenge is to determine methods to identify recovery-related therapeutic targets and prognostic factors.

The innovations for this study include: determining the mechanisms giving rise to the MEG signals from stroke, using MEG to detect low (DC) or high frequency signal changes after stroke, determining if MEG measurements will provide a non-invasive interpretation of stages of cell death or recovery occurring after stroke, defining prognostic indicators of recovery from MEG analysis, and providing physicians with MEG markers or factors to identify recovery-related neuronal events to determine the course of treatment.
S-07-1

Graded magnetoencephalographic analysis for patients with epilepsy: for the global application for every patient with epilepsy

Hideaki Shiraishi 1), Fumiya Takeuchi 2), Keitaro Sueda 1), Naoko Asahina 1), Shingo Nakane 3), Steven M. Stufflebeam 4), Shinobu Kohsaka 1), Shinji Saitoh 1)

1) Department of Pediatrics, Hokkaido University, Graduate School of Medicine, Sapporo, Japan
2) Department of Health Science, Hokkaido University, School of Medicine, Sapporo, Japan
3) Division of Magnetoencephalography, Hokkaido University Hospital, Sapporo, Japan
4) Athinoula A. Martinos Center for Biomedical Imaging, Boston, USA

Purpose: In this present study, we evaluate a combination of spatial filter and time-frequency analyses for magnetoencephalography (MEG) to demonstrate widespread or multi-focal epileptogenic regions and localizations of rhythmic spike activities that are hardly estimated by conventional single dipole model (SDM).

Methods: We performed MEG for 109 cases with epilepsy: 85 cases with symptomatic localization-related epilepsy (SLRE), 5 with symptomatic generalized epilepsy (SGE), 15 with idiopathic localization-related epilepsy (ILRE), 2 with idiopathic generalized epilepsy (IGE), 2 with undetermined epilepsy (UDE). MEG data were recorded by 204 ch helmet shape gradiometers (Neuromag) with 600Hz sampling rate. The MEG data were calculated by SDM, spatial filter analysis: dynamic statistical parametric mapping (dSPM), and time-frequency analysis: short time Fourier transforms (SFT).

Results: SDM estimated dipoles in 83 cases including 65 (76%) cases with SLRE, 12 (80%) with ILRE, 3 (60%) with SGE, a case (50%) with IGE, 2 (100%) with UDE. We performed dSPM in the other 26 cases. dSPM showed widespread epileptic foci in 16 cases (10 with SLRE, 3 with ILRE, 2 with SGE, a case with IGE). SFT showed representative bundles of rhythmic activities in remaining 10 cases with SLRE.

Conclusions: Using above three methods, we successfully localized dipoles in most of LRE and UDE. Advanced analyses of dSPM, SFT showed wide-spread or recruiting activities in cases that SDM failed to project dipoles and made diagnosis of proper GE.

S-07-2

Magnetoencephalography of childhood benign epileptic syndromes: Panayiotopoulos syndrome and Gastaut type idiopathic childhood occipital epilepsy

Jun Tohyama

Department of Pediatrics, Epilepsy Center, Nishi-Niigata Chuo National Hospital, Niigata, Japan

Benign localization-related epilepsies in children include benign childhood epilepsy with centrotemporal spikes, Panayiotopoulos syndrome (PS) and Gastaut type idiopathic childhood occipital epilepsy (G-ICOE). Both PS and G-ICOE show occipital spikes on interictal electroencephalography (EEG). However, clinical manifestations of two syndromes are different. To evaluate the characteristics of interictal spikes in two syndromes, we performed magnetoencephalography (MEG) in 25 patients with PS and in 4 patients with G-ICOE. Equivalent current dipoles (ECDs) were calculated at initial peak of each interictal spike discharge. In PS, ECDs were diffusely located in occipital (9 patients), parietal (7 patients), parietal and occipital (3 patients), frontal (3 patients), or frontal and occipital (1 patient) with tight clustering and vertically oriented to the sulci. The frontal ECD occurred in relatively older patients than those with parieto-occipital ECDs. ECDs of G-ICOE in three patients were scattered in occipital region, and the other one patient showed the clusters along the cortical sulcus in occipital lobe. Diffuse localized ECDs in PS indicated cortical hyper-excitability, not only occipital origin. Patients with G-ICOE showed different findings and patterns of ECDs localization from PS patients. Visual symptoms in G-ICOE may be related to spread of spike discharges in occipital lobes including visual fields.
Pediatric epilepsy surgery and magnetoencephalography

James W. Wheless

Division of Pediatric Neurology and the Neuroscience Institute, University of Tennessee Health Science Center, Memphis, USA

Epilepsy surgery in children is distinctly different from that performed in adults. Pediatric epilepsy surgery usually involves extratemporal or multilobar resections, hemispherectomy, and corpus callosotomy. It is these distinct differences compared to adult epilepsy surgery that allow MEG's unique abilities to be utilized. MEG may help characterize the irritative zone (interictal abnormalities) and assists in the performance of functional mapping. This is especially important in children as most of their epilepsy surgeries are non-temporal and many are multilobar. MEG also allows us to define the relationship of the irritative zone to eloquent cortex and define the relationship of the irritative zone to a lesion, if present. All of this information can be incorporated into a frameless, stereotaxic neuron-navigational system allowing intraoperative identification of the corresponding brain regions. MEG also assists in determining the prognosis of outcome following epilepsy surgery in children. MEG is ideally suited to the pediatric epilepsy surgery candidates, as it is safe, painless, and non-invasive. A single discrete cluster of dipoles appears to be the most predictive MEG pattern, to accurately define the epileptogenic zone and predict a good surgical outcome.

Magnetoencephalography and intracranial video EEG in pediatric intractable epilepsy

Hiroshi Otsubo, Ayako Ochi

Division of Neurology, The Hospital for Sick Children, Toronto, Canada

Clinical applications of MEG in children include the evaluation and treatment of intractable epilepsy. We reviewed interictal MEG spike sources (MEGSSs) with ictal findings on intracranial video EEG (IVEEG) for epilepsy surgery.

We classified the distributions of MEGSSs. Clustered MEGSSs consisted of ≥6 MEGSSs with ≤1 cm distance. Scattered MEGSSs consisted of <6 MEGSSs or regardless MEGSSs with >1 cm distance. Using 3D surface rendering MRI we compared the distributions of MEGSSs with those of ictal high frequency oscillations (HFOs). We analyzed correlations among the surgical resection area, MEGSSs, ictal HFOs, histopathology and surgical outcome.

The clustered MEGSSs were localized within the ictal onset zone with ictal HFOs in most cases with cortical dysplasia. The extent of ictal symptomatic zone with consecutive HFOs was partially overlapped with clustered MEGSSs, spread to scattered MEGSSs in some cases with other pathologies. The complete resection of clustered MEGSSs and maximum resection of the ictal zone with faster and higher power of HFOs provided seizure free outcome.

The distribution of clustered MEGSSs indicated the ictal onset zone. The extended HFOs during clinical seizures beyond clustered MEGSSs might be explained by different states between interictal MEG with medications and ictal IVEEG without medications.
On the relationships between epileptiform activity and neurocognitive development

Jeffery D. Lewine 1), Michael C. Smith 2), Michael Stein 2), Sookyong Koh 3), Richard A. Andrews 4)

1) Illinois MEG Center and the Alexian Brothers Center for Brain Research, Alexian Brothers Hospital Network, Elk Grove Village, USA
2) Department of Neurology, Rush University Medical Center, Chicago, USA
3) Department of Neurology, Children's Memorial Hospital, Chicago, USA
4) RA Neurological, Omaha, USA

Several lines of data converge to indicate that epileptiform activity, even in the absence of clinical seizures, can have a negative impact on cognitive development of children. MEG provides an excellent tool for exploring the consequences of epileptiform activity because it provides detailed information on the location of the epileptogenic cortex. Using MEG it is now becoming clear that the location of the dysfunctional cortex is key in determining its cognitive consequences. For example, even when epileptic spiking is nearly continuous during sleep, if the generative region is the inferior rolandic cortex [as is seen in benign rolandic epilepsy], the cognitive consequences are minimal. In contrast, even mild epileptiform involvement of peri-sylvian cortex can have a significant impact on language development. This presentation will discuss the research and clinical role of MEG in evaluating children with Rolandic epilepsies, tuberous sclerosis complex, ADHD, Landau-Kleffner Syndrome, and the autism spectrum disorders. Of particular note will be evidence that MEG is superior to EEG in evaluating conditions where epileptiform activity is suspected in the peri and intra-sylvian regions.

The attentional effect in attention deficit hyperactivity disorder (ADHD) by magnetoencephalography (MEG)

Alejandra Carboni 1), Almudena Capilla 1,2), Elena Pérez 3), Fernando Maestú 1, 2), Tomás Ortiz 1), Javier González 2)

1) MEG Center Dr Pérez Modrego, Complutense University of Madrid, Madrid, Spain
2) Department of Basic Psychology II, Faculty of Psychology, Complutense University of Madrid, Madrid, Spain
3) Developmental and Educational Psychology Department, Complutense University of Madrid, Madrid, Spain

Most of current theories regarding attention-deficit/hyperactivity disorder (ADHD) postulate that the core cognitive deficit is an executive dysfunction. Neuroimaging studies have provided evidence supporting the fronto-striatal dysfunction hypothesis in ADHD. However, recent neuroimaging studies have also found anatomical and functional impairments in posterior cortical regions. Moreover, event related potential (ERP) studies have shown impairment in early components, such as P1 or N1, both sensitive to selective attention effects. These findings cast doubt regarding the fronto-striatal/executive dysfunction as the core deficit in ADHD.

This study aimed to test the lack of attentional effect in ADHD children. We used magnetoencephalography (MEG) to measure event-related brain activity during a perceptive task and during a selective attention task in children with DSM-IV combined type ADHD (ADHD-C) or predominantly inattentive type ADHD (ADHD-PI) and in age and intelligence-matched control children.

We posited that control group children would present the attentional effect; this is higher intensity in brain activation during the attention task compared to the perceptive task. In contrast, ADHD children would not show the attentional effect. Specifically, ADHD-C group would present higher activity in both tasks (stimuli hyper-reactivity), while ADHD-PI group would show lower brain activation in the perceptive as well as the attentive tasks.
**S-08-3**

Anatomical asymmetry of the M100 source in typically developing children and children with autism spectrum disorders

Gwen L. Schmidt, Michael M. Rey, Timothy P. L. Roberts

Department of Radiology, Children's Hospital of Philadelphia, Philadelphia, USA

Healthy adults show an asymmetry of the auditory M100 ECD source such that the right auditory cortex source is anterior to the left, while individuals with dyslexia and schizophrenia show a reduction or reversal of such asymmetry (Edgar 2006). These findings are consistent with structural asymmetry differences in the planum temporale in schizophrenia and dyslexia (Shapleske 1999). Such atypical functional and structural asymmetries may be related to auditory processing abnormalities leading to language difficulties. While atypical structural asymmetry differences have also been found in autism spectrum disorders (Rojas 2002, 2005), and language difficulties are characteristic of autism, the corresponding functional asymmetries relating to the M100 have not been investigated. Furthermore, some characteristics of the M100 only emerge during development (Oram Cardy 2004). In the current study, evoked neural activity to a 1 kHz tone was recorded using a whole cortex, 151-channel MEG in a control group of healthy adults, typically developing children, and children with autism spectrum disorders. Subsequently an ECD model was used to identify the source of each M100 generator in the auditory cortex. The healthy adults displayed the expected right-sided anteriority while the children with autism displayed a developmental trajectory with only older children showing this pattern.

**S-08-4**

Electrophysiological endophenotypes of language impairment in autism: MEG studies

Timothy P. L. Roberts

Department of Radiology, Children's Hospital of Philadelphia, Philadelphia, USA

The clinical profiles of several developmental disorders, including autism spectrum disorders (ASD), involve varying degrees of co-morbid language impairment (LI). Clinical diagnosis of LI, however, does not itself identify the associated underlying neuronal deficit(s), which may occur at the level of perception, processing, and/or cognition, given the observed heterogeneity of LI. Current understanding of how a deficit at each or any of these levels might relate to LI is not sufficiently sophisticated to distinguish neuronally-based subtypes of LI. Such classification may, on the one hand, reproduce existing clinical categories, or, on the other hand, cut across clinical diagnoses and instead group together language impaired individuals by the nature of their underlying neuronal deficit. The ongoing research program addresses delineating subtypes of LI identified via parametric investigation of evoked neuromagnetic activity during speech perception, processing, and cognition in young clinical populations including children with various ASD diagnoses vs. typically developing peers. MEG data will be reported from studies of sound detection and encoding, rapid temporal processing and change detection, each of which shows atypical neuromagnetic response in ASD. As such, it is the goal of this endeavor to define electrophysiological signatures, or endophenotypes, associated with the neural correlates of LI in ASD across a range of sound and speech processing stimuli to address both the heterogeneity of the behavioral impairment across the spectrum within the diagnosis of ASD (the “heterogeneity” problem) and to provide candidate measures to address the apparent overlap in behavioral impairment between different diagnoses (the “overlap” problem). Additionally, the use of characteristic brain-level endophenotypes will be suggested as a mechanism for tightening the connection between experimental and clinical laboratories. Experimental (e.g. genetic) models of autism might now be evaluated in terms of such electrophysiological (as well as behavioral) traits associated with ASD and thus provide a more specific approach for understanding the underlying neurobiology.
S-09-1

Concepts of the epileptogenic zone: use of pre- and intraoperative MSI for epilepsy surgery

Hermann Stefan

Epilepsy Center, University Hospital Erlangen, Erlangen, Germany

Introduction: Precondition for successful epilepsy surgery is optimal patients selection. Whereas in former times EEG, MRI and neuropsychology were used for presurgical evaluation, nowadays a multimethodological approach including coregistration of imaging and electrophysiology (MEG) is available. Presurgical evaluation should be carried out if a drug resistance exists. The time to diagnose drug resistance should be within one or two years.

Method: In order to get a more shortcut way to presurgical evaluation and epilepsy surgery noninvasive diagnostic tools like MSI could be used for screening of candidates. The existing conceptual hypothesis of epileptic zones is discussed with regard to the historical developments and the concept of large networks. The aim of presurgical evaluation is to determine the generating subnetwork within the physiological network in the brain. Here one has to differentiate between the irritative (primary and secondary part of the network) and the seizure onset part. In addition to the localization of the focal epileptic activity also the functional network areas for motoric, sensoric-speech region and memory have to be considered. The contribution of MEG/EEG for presurgical evaluation with regard to epilepsy surgery is demonstrated.

Conclusion: Noninvasive presurgical evaluation for functionally preserving epilepsy surgery can be improved by means of multimodal MSI recording. Previously unsuccessfully operated patients can be reoperated successfully.

S-09-2

MEG can characterize the epileptogenicity in neocortical epilepsy: evidence from postoperative long-term seizure outcome

Makoto Oishi 1), Hiroatsu Murakami 2), Hiroshi Masuda 2), Shigeki Kameyama 2), Masafumi Fukuda 1), Yukihiko Fujii 1)

1) Department of Neurosurgery, Brain Research Institute, Niigata University, Niigata, Japan
2) Department of Neurosurgery, National Nishi-Niigata Chuo Hospital, Niigata, Japan

Epilepsy surgery for neocortical epilepsy sometimes resulted in poor seizure outcomes even after confirmation of cortices to be resected with invasive intracranial recordings. To clarify whether MEG can characterize such epileptogenicity or intractability of neocortical epilepsy, we investigated 30 patients who underwent cortical resection after subdural recording and who have been followed for 4 years or more. We obtained equivalent current dipole (ECD) clusters of interictal MEG discharges in 26 patients (87%). The seizure onset was identified in the proximity of ECD clusters in 24 (92%). Based on distributions and directions of ECDs, cluster formations were categorized into 3 single-cluster groups, a focal and parallel cluster, a focal but multidirected cluster, and a wide cluster, and a multiple-cluster group. Large or multiple cortical resection was required in 11%, 67%, 100%, and 100%, and good long-term outcome (Engel's class 1 or 2) was obtained in 89%, 100%, 75%, and 38%, for respect groups. Our results indicated that ECD clusters of interictal MEG discharges not only identify the seizure onset but also correlate with the required extent to be resected and postsurgical seizure outcome. We conclude the interictal MEG analysis can characterize the epileptogenic zone or network generating individual patients' epilepsy.
S-09-3

Does MEG/EEG focality predict good postoperative seizure control after epilepsy surgery?

Stefan Rampp, Andrea Paulini, Martin Kaltenhäuser, Tanja Ehrenfried, Hermann Stefan

Epilepsy Center (ZEE), Department of Neurology, University Hospital, Erlangen-Nuremberg, Germany

Background: Epilepsy surgery is an option for patients with pharmacoresistant focal epilepsies. Rapid estimation of seizure free postsurgical outcome would considerably help to advise patients about its viability. The presented study investigates focality of MEG/EEG epileptic activity as a single predictor for rapid screening applications.

Method: Focality characteristics of MEG/EEG spikes of 30 surgically treated epilepsy patients were calculated. Simultaneously recorded MEG/EEG data were inspected visually; spikes were automatically analyzed using single dipole localization in a realistic volume conductor. Results were inserted additively into a 3D-volume. Volume of smallest convex hull enveloping voxels with most dipole localizations (>99th percentile) was used to describe focality and compared to postsurgical outcome, classified into groups Engel outcome 1 and 2-4.

Results: Focality was higher in patients with postoperative Engel outcomes 1 compared to patients with outcomes 2-4. This difference reached statistical significance for MEG (p<0.05), for EEG, a tendency was observed (p<0.1). Correlation to outcome was 0.33 (p<0.05) for MEG alone, but was better when both modalities were combined (0.42, p<0.05).

Conclusion: Focality was found to be a viable estimation parameter for epilepsy surgery outcome with best results being achievable by combining MEG and EEG. Automatic calculation offers a method for screening applications.

S-09-4

Can MEG substitute some of the invasive procedures in epilepsy surgery? - Evidences from outcome studies

Eduardo M. Castillo, Andrew C. Papanicolaou

Departments of Pediatrics, Neurology and Neurosurgery, University of Texas-Houston, Houston, USA

In this review we present two studies conducted to test the clinical validity of magnetoencephalography (MEG) for the presurgical evaluation of epileptic patients. In the first study, including 41 consecutive patients, we compared the localization accuracy of interictal MEG with ictal and interictal invasive video electroencephalography (VEEG) in identifying the epileptogenic zone. This comparison was based on the degree of overlap between the location of the actual surgical resection and the zone identified by each method, taking into consideration the success of surgery in reducing seizure activity. No statistical differences were observed between the accuracy of invasive VEEG and MEG in determining the location of the seizure zone across this group of patients. In the second study, we compared the cortical topography of language-specific cortex as delineated by direct electrocortical stimulation (ECS) and by MEG. The relative merit of both methods in identifying “essential” language cortex was tested on the basis of postsurgical linguistic outcome. The results indicated that estimates from MEG and ECS had a similar ability to predict linguistic regression after surgery (i.e., naming/fluency worsening). Direct recordings of neurophysiologic signals using MEG are a valid alternative to some of the current invasive procedures and can help to prevent functional morbidity in patients undergoing epilepsy surgery.
Cerebral motor control in patients with brain tumors around the central sulcus studied with synthetic aperture magnetometry

Amami Kato 1), Satoru Oshiro 2), Masayuki Hirata 2), Masaaki Taniguchi 2), Koichi Hosomi 2), Naoki Tani 2), Toshiki Yoshimine 2)

1) Department of Neurosurgery, Kinki University, Osaka-Sayama, Japan
2) Department of Neurosurgery, Osaka University, Osaka, Japan

Synthetic aperture magnetometry (SAM) was applied to investigate changes in the mechanism of cerebral motor control in patients with tumors around the central sulcus in relation to the clinical symptom. MEG records were made with a repetitive hand grasping task in patients and in four control subjects. Topographic appearance of abnormal focal slowing in delta, theta, and alpha bands and event related desynchronizations (ERD) in alpha, beta, and low gamma bands during motor tasks were analyzed statistically with SAM in relation to clinical signs and symptoms. Distribution of enhanced focal delta activity was coincident with the motor cortices responsible for weakness. Volumetric analysis revealed tumor-related focal delta activity was greater for intra-axial tumors involving subcortical fibers than for other extra-axial tumors. In addition, patients with increased volume of enhanced delta activity exhibited poor functional recovery in early postoperative period. Beta ERD in patients during affected hand movement was also localized exclusively to ipsilateral hemisphere contrary to normal pattern. The characteristic focal delta distribution and altered patterns of ERD in the patient group suggest not only close relation of cortical function and existing pathology but recruitment of diverse motor areas which may be required for the effective movement of the affected side.

Presurgical mapping and neuronavigation: experience of Seoul National University Hospital

Chun Kee Chung, June Sic Kim

MEG Center, Department of Neurosurgery, Seoul National University Hospital, Seoul, Korea

Background: With development of neuroimaging methods, mapping of indispensable functions such as motor, somatosensory, visual, auditory, and high cognitive functions including language and memory has been possible preoperatively. Combined with neuronavigation system, we can now use this preoperative mapping result in surgery. In the study, we validate the neuronavigation system.

Materials and Methods: Seoul National University Hospital MEG center has been developing our own solutions to localize brain functions. With MEG, somatosensory, auditory, visual or motor functions are routinely mapped depending on the location of lesions. Language and memory mapping is in development. Also functional mapping could be combined with tractography. We excluded cases using preoperative interictal MEG spike mapping with navigation in this abstract. In collaboration with CyberMed Company, functional mapping, tractography, PET, CT, angiography or brain atlas are routinely available to surgeons intraoperatively.

Results: We have used preoperative mapping and neuronavigation in 96 surgeries since September 2005. MEG alone in 86 cases, MEG combined with tractography in 3 cases, and MEG combined with PET in 7 cases. Navigation error was 2.02±0.73 mm. Surgeons' satisfaction was checked. If the surgeon thought presurgical mapping and neuronavigation is helpful, we graded it as success. Otherwise it could be failure. There have been 20 failures. However, the most failures occurred in the early period to settle combining usage of MEG and neuronavigation. Systematic approach to validation has not been tried yet. Comparison with intraoperative mapping result is on planning stage.

Conclusion: Functional mapping using MEG is used in intraoperative neuronavigation. Technological error is acceptable. However, validation has to be done in near future.

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Spatiotemporal signal space separation (tSSS) in clinical practice: a review of 17 cases

Michael E. Funke 1, Myles Reilly 1, Samu Taulu 2, Michael Johnson 1

1 Department of Neurology, University of Utah, Salt Lake City, USA
2 Elekta Neuromag Oy, Helsinki, Finland

Significant artifact contamination often renders clinical MEG scans worthless. Sources of such contamination are, e.g., vagal nerve stimulators (VNS) and dental work. Prior craniotomy also can result in severe artifacts. In this study, we review the efficacy of the tSSS in contaminated MEG data of 17 patients with intractable epilepsy.

MEG data were acquired with an Elekta Neuromag system. Somatosensory functioning was assessed using bilateral electrical stimulation of the median nerves. Sleep was induced by prior sleep deprivation. Approximately 60 minutes of continuous data were recorded. The spatiotemporal signal space separation method (tSSS) was used off-line to remove the artifacts.

Artifacts were caused due to implanted VNS devices in 8 patients, due to prior craniotomies in 4, due to dental work in 4, due to other sources in 2. Spontaneous data quality obtained was excellent in 15 cases, satisfactory in one, and poor in one. Interpretation of the tSSS filtered data unveiled abnormal findings in 14 cases, and was inconclusive in 3. Somatosensory raw data were collected in 11 patients. Applying tSSS and subsequent averaging allowed plausible localization of the N20m complex in 6.

The tSSS filter is an efficient tool that allows successful MEG scan in patients previously not considered suitable for MEG evaluation.

Visualization of the language network on tractography by the co-utilization of MEG and fMRI

Kyousuke Kamada 1), Takahiro Ota 1), Yoshitaka Masutani 1), Shigeki Aoki 2), Kensuke Kawai 1), Nobuhito Saito 1)

1) Department of Neurosurgery, The University of Tokyo, Tokyo, Japan
2) Department of Radiology, The University of Tokyo, Tokyo, Japan

The aim of this study was to visualize language-related subcortical connections, such as the arcuate fasciculus (AF) by diffusion tensor imaging (DTI)-based tractography by combining MEG and fMRI. Twenty-two patients with brain lesions adjacent to the AF in the fronto-temporal regions of the dominant hemisphere were studied. The AF-tractography was created by placing initiation and termination sites (seed and target) in the frontal and temporal regions, which were functionally identified by fMRI with a verb generation task and by MEG with a reading task, respectively. The functional information, including the AF, fMRI and MEG, was imported to a neuronavigation system and validated by bipolar electric stimulation to the cortical and subcortical areas. Co-utilizing the language-fMRI and MEG obviously demonstrated the hemispheric dominance of language functions, which was confirmed by intracranial amobarbital procedure. During awake surgery, the cortical stimulation to the gyrus, including the language-fMRI activation, evoked speech arrest, while the subcortical stimulation close to the AF reproducibly caused "paranomia" without speech arrest and validated the illustrated AF as a real and functioning anatomical structure. The combination of these techniques enabled us to accurately identify the locations of the AF and to verify the language networks.

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ISACM 2007
Application of beamformer algorithm to MEG spontaneous recordings in epilepsy patients with vagal nerve stimulators

Douglas F. Rose 1), Hisako Fujiwara 1), Nat Hemasilpin 2), Ki H. Lee 1), Stephen E. Robinson 3), Jing Xiang 1)

1) Division of Neurology, Cincinnati Children’s Hospital Medical Center, Cincinnati, USA
2) Clinical Engineering, Cincinnati Children’s Hospital Medical Center, Cincinnati, USA
3) Neuromagnetism Laboratory, Henry Ford Hospital, Detroit, USA

Candidates for epilepsy surgery may have had prior placement of a vagal nerve stimulator (VNS). The presence of a VNS causes very high magnetic noise in the MEG signals, obscuring spontaneous magnetic brain activity. Beamformer analysis can diminish both nearby and distant magnetic noise sources. We studied 5 children and adults with intractable epilepsy who each had prior VNS placement. We recorded 275 channels MEG and 23 channels simultaneous scalp EEG in standard 10-20 placement. We examined raw signals of MEG, simultaneous bipolar EEG, and MEG processed with a beamformer analysis, synthetic aperture magnetometry (SAM), at 323K intracranial virtual sensor locations. We evaluated a statistical measure of increased kurtosis, SAM(g2) that reflects increased spikiness of source activity for each virtual sensor location. We compared location, morphology, and timing of epileptiform discharges seen in the EEG signals with spikes detected in the virtual sensors by SAM(g2) (VS-spikes). The patients had 13 to 90 epileptiform discharges recorded and 25 to 193 VS-spikes recorded. Peak SAM(g2) VS-spikes were found at multiple locations in same lobe as EEG, and had shorter duration than in the EEG. VS-spikes were detected just prior to and during discharges detected by EEG. Beamformer analysis allows interpretation of magnetic brain activity that would otherwise be obscured by VNS.

Clinical, MEG and neuroimaging analyses of patients with malignant rolandic-sylvian epilepsy in children

Kazuhiro Haginoya 1.4), Nobukazu Nakasato 2), Mitsugu Uematsu 1), Taro Kitamura 3), Tomoko Kobayashi 1), Yoko Matsumoto 1), Naomi Fukuyo 1), Shigeru Tsuchiya 1)

1) Department of Pediatrics, Tohoku University Graduate School of Medicine, Sendai, Japan
2) Department of Neurosurgery, Kohnan Hospital, Sendai, Japan
3) Department of Pediatrics, Sendai City Hospital, Sendai, Japan
4) Department of Pediatric Neurology, Takuto Rehabilitation Center for Children, Sendai, Japan

Rationale: To characterize clinical and neurophysiological features of malignant rolandic-sylvian epilepsy (MRSE) in children (Otsubo et al. 2001) that has been defined as a form of epilepsy characterized by sensorimotor seizures, medical refractoriness, normal MRI, frontocentrotemporal EEG spikes, rolandic-sylvian spike sources on MEG, and cognitive problems. Methods: Four patients were included in this study. Results: MEG demonstrated that spike sources clustered on the bilateral rolandic area in pts 1-2, and unilateral rolandic area in pts 3-4. In contrast to benign rolandic epilepsy where spike sources have anterior/superior direction, all in MRSE showed posterior/inferior direction. Patients were divided into two subgroups. Group 1 (pts 1-2) had frequent seizures appeared every 10 minutes that were characterized by blinking, facial twitching, and head dropping. Ictal EEG showed synchronous spike-waves bursts. CSWS was observed. Ictal SPECT showed hyperperfusion in the subcortical gray matters. Ethosuximide finally had substantial effect in controlling seizures and improving EEG findings as well as cognitive problems. Group 2 (pts 3-4) had intractable hemiconvulsion (pt 3) and versive/postural tonic seizures (pt 4). Ictal EEG originated from central region. CSWS was not observed. Ictal SPECT showed hyperperfusion in the rolandic region. Conclusions: Although this is a preliminary analysis, MRSE in children may be divided into two subgroups as described above. From MEG, parietal cortex at rolandic area seemed to be responsible for spike sources.
P-A-03

Comparison of interictal MEG with electrocorticogram and intraoperative hippocampal electrogram in temporal lobe epilepsy

Naohiro Tsuyuguchi, Yoshihito Shigihara, Yuzo Terakawa, Michiharu Morino, Kenji Ohata

Department of Neurosurgery, Osaka City University Graduate School of Medicine, Osaka, Japan

We compared interictal MEG; chronically-implanted subdural electrocorticogram (ECoG) over the lateral, basal, and mesial temporal area; and intraoperative hippocampal electrogram in 16 patients with intractable temporal lobe epilepsy. They were followed up for more than one year after resection surgery. MEG and subdural ECoG were simultaneously measured in a magnetically shielded room; hippocampal signals were also measured using intraventricular hippocampal surface electrode (IHSE) during selective amygdalohippocampectomy or multiple subpial transaction of hippocampus.

Most of the subdural ECoG spikes showed negative peaks, whereas those obtained with IHSE showed positive peaks. Time lag between ECoG spike and MEG spike was various, and mostly more than 2 ms. In 9 cases, MEG detected no spikes whereas intracranial EEG detected. In 2 cases, interictal MEG appeared exclusively contralateral to the ictal ECoG hemisphere. There was no correlation of postoperative seizure outcome (Engel's class) between cases with and without MEG. Our present results correspond to the previous reports that MEG hardly detects mesial temporal lobe epileptic spikes probably because their signal sources are too deep and not constantly horizontal to the scalp surface.

P-A-04

Effects of total intravenous anesthesia by propofol on MEG for pediatric patients with intractable epilepsy

Ayataka Fujimoto, Ayako Ochi, Rohit Sharma, Amrita Hunjan, Bill Chu, Staphanie Holowka, Sheelagh M. Kemp, Sylvester H. Chuang, Carter O. Snead III, Hiroshi Otsubo

Division of Neurology, The Hospital for Sick Children and the University of Toronto, Toronto, Canada

Rationale: Sedations for uncooperative children are necessary to keep patients immobile during MEG and MRI. It is little known that sedation effects for interictal epileptiform discharges (IEDs) on MEG. We evaluate total intravenous anesthesia (TIVA) using propofol for EEG and MEG.

Patient and Method: We selected 28 uncooperative patients who underwent scalp video EEG monitoring (VEEG) before magnetoencephalography (MEG) studies. There were 12 boys and 16 girls. The age ranged from 3 to 14 years old (mean 6.6 years old). We performed MEG recording using 151-channel gradiometers whole head type with 625Hz sampling rate. We maintained propofol (30-60µg/kg/min) and titrated remifentanil to the lowest dose necessary for keeping the patients still.

Result: Seventeen (94%) of 18 patients with MRI lesion provided more MEG clustered dipoles than four (40%) of 10 patients without MRI lesion (p<0.01). MEG showed clustered dipoles in a single lobe in 13 (72%) of 18 patients with MRI lesions comparing with three (30%) of 10 patients without MRI lesion (p<0.05). There was a tendency that the frequency of interictal epileptiform discharges (IEDs) on EEG in the non-lesional group was more declining than that in the lesional group (p=0.057).

Conclusion: Although total intravenous anesthesia (TIVA) for the uncooperative pediatric patients reduced IEDs, MEG could localize the single clustered dipoles in most of lesional cases. In most of non-lesional cases with focal IEDs on scalp EEG, MEG under TIVA did not localize conclusive dipoles. The reduced amplitude and frequency of IEDs by TIVA were considered to affect the extent of zone and the density of MEG dipoles.
P-A-05

Magnetoencephalographic (MEG) analysis in two epilepsy patients with negative myoclonus

Hideji Hattori 1), Hisashi Kawawaki 2), Ichiro Kuki 2), Satoru Sakuma 1), Toshiaki Yokoi 1), Osamu Matsuoka 1), Tunekazu Yamano 1)

1) Department of Pediatrics, Osaka City University Graduate School of Medicine, Osaka, Japan
2) Department of Child Neurology, Children's Medical Center, Osaka City General Hospital, Osaka, Japan

Magnetoencephalographic (MEG) analysis was performed in two epilepsy patients with negative myoclonus. Interictal MEG/EEG was evaluated in each patient. Estimated equivalent dipole (ECD) was located at the primary somatosensory cortex (SI) in both patients. The generator of epileptic negative myoclonus (ENM) in both patients may be located in SI.

ENM is a brief and abrupt interruption of muscular activity time-locked to epileptiform EEG activity. Negative myoclonus occurs frequently with metabolic encephalopathies and also occurs in epilepsy syndrome. Subdural EEG recordings were used to study the generator of ENM. There were a few reports about the magnetoencephalography (MEG) about the ENM. We performed MEG analysis in two epilepsy patients with negative myoclonus. Interictal MEG/EEG was evaluated in each patient. Case 1 is 11-years-old girl suspected with atypical benign partial epilepsy who presents left hand brief tonic seizure and left hand ENM. Ictal EEG showed right parietal spikes and waves. Case 2 is five-years-old girl with CPS who presents drop attacks to right side. Interictal EEG showed Cz spikes in sleep. ECD was located at the right postcentral gyrus, the primary SI, in both patients. The generator of ENM in both patients may be located in SI.

P-A-06

MEG-directed epilepsy surgery for patients with congenital bilateral/unilateral perisylvian syndrome

Hiroatsu Murakami 1), Shigeki Kameyama 1), Ayataka Fujimoto 1), Ichiro Sugiyama 1), Hiroshi Masuda 1), Akiyoshi Kakita 2), Hitoshi Takahashi 2)

1) Department of Neurosurgery, Epilepsy Center, Nishi-Niigata Chuo National Hospital, Niigata, Japan
2) Department of Pathology, Brain Research Institute, Niigata University, Niigata, Japan

Objective: There was no report of successful focus resection in patients with congenital bilateral or unilateral perisylvian syndrome (CB/UPS) because focus localization is impossible in conventional presurgical evaluation. To establish surgical strategy for patients with CB/UPS associated with refractory seizures and to identify the utility of MEG for focus localization.

Method: Magnetic source imaging (MSI) identified single ECD cluster on the superior temporal gyrus in 3 patients ( 2 males and 1 female) with CB/UPS. MSI showed a guide for implantation of subdural grid and depth electrodes in 2 and a guide for tailored resection of the ECD cluster in one. Age at operation was 16, 21, and 4 years old (mean age, 13.6 years).

Results: In 2 patients, ictal intracranial recording demonstrated the seizure onset zone identical to the ECD cluster of MSI. Non-eloquent foci of superior temporal gyrus were safely resected without complications. All patients achieved seizure freedom and functional improvement in the follow-up period of 6-20 months. Pathological examination disclosed polymicrogyria in all patients. In 2 of them, polymicrogyria was associated with focal cortical dysplasia type IIA or type IIB (Palmini, 2004).

Conclusion: MSI can provide unique localization information of the focus in such wide-lesional CB/UPS. MEG is useful to guide placement of intracranial electrodes and focus resection.
P-A-07

Neuromagnetic localization of spike sources in perilesional, contralateral mirror, and ipsilateral remote areas in patients with cavernoma

Kazutaka Jin 1), Nobukazu Nakasato 2, 3), Hiroshi Shamoto 2), Akitake Kanno 3), Yasuto Itoyama 1), Teiji Tominaga 4)

1) Department of Neurology, Tohoku University Graduate School of Medicine, Sendai, Japan
2) Department of Neurosurgery, Kohnan Hospital, Sendai, Japan
3) Tohoku Ryogo Center, Kohnan Hospital, Sendai, Japan
4) Department of Neurosurgery, Tohoku University Graduate School of Medicine, Sendai, Japan

EEG and MEG were simultaneously recorded in 17 patients (8 men, mean age 29.7 years) with single cavernoma. The location of the equivalent current dipole (ECD) of the interictal spikes was correlated with the lesion shown by MRI. Preoperative ECD localization was classified into 4 types: perilesional, adjacent to the cavernoma only (n=6); mirror, adjacent to the lesion and at the contralateral homologous site (n=5); remote, mainly at a remote site in the ipsilateral hemisphere (n=3); and no spikes (n=3). The spikes were detected by only MEG in 2 of five "mirror" and all three "remote" patients. In the mirror group, contralateral spikes were synchronized with the ipsilateral spikes, or also occurred independently. Two "perilesional" and two "mirror" patients became seizure-free and spike-free after extended lesionectomy. In contrast, the other two "mirror" patients had residual seizures and spikes after pure lesionectomy. The detectability of mirror and remote spikes was higher by MEG than by EEG. Therefore, the use of both EEG and MEG will provide the maximum information about spike distribution and propagation. Residual seizures and spikes after pure lesionectomy, but not after extended lesionectomy, in the "mirror" patients suggest the importance of resection of the perilesional irritable zone.

P-A-08

Preoperative evaluation using gradient magnetic-field topography (GMFT) for magnetoencephalography in patients with neocortical epilepsy

Hiroshi Shirozu, Koji lida, Akira Hashizume, Ryosuke Hanaya, Kaoru Kurisu

Department of Neurosurgery, Hiroshima University, Hiroshima, Japan

Objective: We newly developed gradient magnetic field topography (GMFT) to show spatial and temporal dynamics of epileptic spikes on brain surfaces. This study aims to elucidate the usefulness whether GMFT can analyze the epileptic spikes as presurgical evaluation in patients with neocortical epilepsy.

Methods: We retrospectively analyzed MEG data in 7 patients who underwent respective surgery based on the results of extraoperative subdural EEG (SDEEG). MEG was performed with Neuromag System (whole-head type, 306 channels, Elekta-Neuromag O.Y., Helsinki, Finland) including 204 channels of planar gradiometers. We selected the activating area of GMFT during the periods between start and peak of each interictal spike as the onset of epileptic spikes. We compared the results of GMFT with the epileptogenic zones based on SDEEG.

Results: The epileptogenic zones were localized in the frontal (1), frontotemporal (2), temporal (2), central (1) and mesial occipital (1) regions according to the SDEEG. The epileptogenic areas on GMFT showed the colocalized epileptogenic zones with SDEEG in all patients.

Conclusion: GMFT of interictal spikes showed the epileptogenic zones and may be useful method of MEG for preoperative evaluation in patients with intractable neocortical epilepsy.
Presurgical identification of epileptogenic area using multimodal evaluation: MEG, iomazenil SPECT and FDG-PET

Hirotomo Ninomiya 1), Amami Kato 2), Masayuki Hirata 3), Haruhiko Kishima 3) Satoru Oshino 3), Toshiki Yoshimine 3), Katsumi Imai 4)

1) Department of Neurosurgery, Sakai Municipal Hospital, Sakai, Japan
2) Department of Neurosurgery, Kinki University, Osaka-Sayama, Japan
3) Department of Neurosurgery, Osaka University, Osaka, Japan
4) Department of Pediatrics, Osaka University, Osaka, Japan

The aim of this study was to evaluate the usefulness of the multimodal analysis. MEG, IMZ-SPECT, and FDG-PET correspond with electrophysiological study, receptor distribution, and metabolism respectively. Before the surgery, MEG, IMZ-SPECT and FDG-PET were all implemented in the interictal state. MEG was analyzed by dipole method. Following visual analysis of IMZ-SPECT and FDG-PET, statistical analysis was added for IMZ-SPECT. The final definition of epileptogenic area was made by the electrocorticography, pathology, and the prognosis of epilepsy. We applied this analysis to three patients of temporal lobe epilepsy. In the first case, FDG-PET estimated bilateral temporal lobe exaggeratedly. IMZ-SPECT and dipole localization indicated unilateral resected temporal lobe epilepsy. In the second case, dipoles were localized not on the temporal lobe but on the ipsilateral insula. IMZ-SPECT and FDG-PET showed unilateral temporal epilepsy. Epileptogenic area was confirmed on the temporal lobe after the epilepsy surgery. In the third case, dipole localization and SPECT indicated narrower temporal cortex than the one estimated by FDG-PET. The patient became seizure free after temporal lobe corticectomy. Each method had different property to detect the abnormality. Precise evaluation of multimodal examination was useful for the presurgical epileptogenic area.

Profound inspection of interictal epileptiform discharges: application of synthetic aperture magnetometry to detect epileptogenic zone in children with epilepsy

Hisako Fujiwara 1), Douglas F. Rose 1), Nat Hemasilpin 2), Stephen E. Robinson 3), Jing Xiang 1), Ki H. Lee 1)

1) Division of Neurology, Cincinnati Children's Hospital Medical Center, Cincinnati, USA
2) Clinical Engineering, Cincinnati Children's Medical Center, Cincinnati, USA
3) Neuromagnetism Laboratory, Henry Ford Hospital, Detroit, USA

Presurgical evaluation for medically intractable epilepsy must localize seizure foci for resection. SAM(g2) uses synthetic aperture magnetometry (SAM), measures excess kurtosis(g2), and evaluates for "spike-like" activity different from background activity. High cortical irritability (spikiness) can still hide as "noisy" background or poor SNR. To address this caveat of SAM(g2), we added SAM virtual sensors (SAM-VSs) in "3D-grids" in the brain. Seven patients with intractable epilepsy, were studied presurgically with MEG (VSM-MedTech, Port Coquitlam) at 300 Hz and/or 4 kHz sampling rate at least for 30 minutes recording. Size and position for 3D-grids of SAM-VSs were selected based on original SAM(g2) peaks and MRI lesion, if present. Voxel-spacing was 5 mm, giving between 420 (7x10x6) and 4056 (12x13x26) virtual sensors. Visual inspection of SAM-VSs waveforms and comparison of timing of spike onset to epileptiform discharges in the raw EEG and MEG signals showed various findings: earlier onset spike on SAM-VSs than raw EEG or MEG spike onset, small regions of higher amplitude SAM-VS spikes, and drop in spike amplitude between adjacent sulci. Visual inspection of 3D-grids of SAM virtual sensors can refine regions of cortical irritability detected by statistical SAM(g2) analysis and may help localize the epileptogenic zone.
Successful screening of neocortical epilepsy using routine MEG recordings

Pauly Ossenblok 1), Albert Colon 1), Jan De Munck 2), Willem Drolsbach 1), Erik Jansen 1), Paul Boon 1)

1) Department of Clinical Neurophysiology, Epilepsy Center Kempenhaeghe, Heeze, The Netherlands
2) Department of Physics and Medical Technology, Free University of Amsterdam, Amsterdam, The Netherlands

It is well known that the diagnosis of a large percentage of the initial awake routine EEG records is inconclusive. In such cases additional sleep deprived EEG is required. We investigated whether with optimal procedures for screening and localizing of interictal epileptiform MEG discharges (MEG spikes) additional EEG recordings could be avoided.

Fifty-four patients with suspicion of localization bound neocortical epilepsy whose routine EEG records were inconclusive underwent routine MEG recordings. This MEG was visually reviewed following the standard procedures of the routine EEG records. Furthermore, equivalent dipole analysis enabled the localization of MEG spike clusters.

Visual inspection of the routine MEG records yielded for 34 of the 54 patients studied (63%) ten or more detected interictal events. For 33 of these patients (61%), the clustering algorithm revealed sub-classes of spikes corresponding clearly to dipolar magnetic field maps. Inverse computations applied on the selected spike sub-averages yielded anatomical plausible localizations for 19 of the patients studied (35%). Furthermore, in the data presented localizations can be distinguished indicating the involvement of specific brain regions, especially, if a large number of spikes occurred in the MEG.

Although the routine EEG records of the patients studied were inconclusive, the MEG yielded a significant number of interictal events, a reliable categorisation of these events or even a plausible localization. However, further evaluation in relation to the epilepsy of the patient is needed to decide whether routine MEG records may replace additional EEG investigations.

Systematic approach of SAMg2 and clustering analysis localizing multiple foci in patients with tuberous sclerosis complex

Kasumi Imai, Hiroshi Otsubo, Yoko Akizuki, Tomoyuki Akiyama, Ayataka Fujimoto, Ayako Ochi, Carter O. Sneed III

Department of Neurology, The Hospital for Sick Children, Toronto, Canada

Rationale: Synthetic aperture magnetometry kurtosis (SAM(g2)) revealed concordant to single clustered equivalent current dipoles (ECDs). We developed a systematic approach of SAM(g2) clustering analysis (CA) for multiple foci in tuberous sclerosis complex (TSC).

Methods: We analyzed MEG (151 channels, VSM Med Tech) in 5 patients with TSC. We localized clustered dipoles containing >=6 ECDs (10-70Hz band pass filter) within 1.7cm distance. For SAM(g2)CA, we selected five datasets with interictal spikes without artifacts. We located 5mm resolution voxels on MRI, calculated kurtosis value at each voxel (20-70Hz band pass filter), and selected active voxels with local peak kurtosis higher than half of maximum value in each dataset. We localized clustered voxels containing >=3 voxels within 1.7cm distance.

Results: There were two clustered ECDs in 4 patients and one cluster in one patient. SAM(g2)CA localized 12 clustered voxels in 5 patients. Eleven clustered voxels overlapped with zones of all 9 clustered ECDs. One clustered voxel overlapped with scattered ECDs.

Conclusions: SAM(g2)CA succeeded in localizing multiple independent epileptic foci in TSC. This systematic analysis using peak kurtosis and clustering analysis for SAM(g2) informed consistently epileptic regions for the analysis of ECDs.
P-A-13

Clinical value of magnetoencephalography (MEG) in localization of epileptogenic areas: report of 39 cases

Guoming Luan 1), Jian Zhou 1), Jilin Sun 2),

1) Department of Neurosurgery, The Brain Sciences Institute of Beijing, Beijing, China
2) MEG Centre, Hebei General Hospital, Beijing, China

Objective: To study the clinical value of magnetoencephalography (MEG) in the localization of epileptogenic zone.

Methods: Subjects were 39 patients with medically intractable epilepsy who underwent MEG and video-EEG monitoring. We compared outcome and clinical effect of MEG with ictal/interictal scalp EEG and intraoperative ECoG.

Result: The concordance rates between MEG and ictal/interictal scalp EEG were 80/77%, and between MEG and intraoperative ECoG was 80%. The rate of MEG and the scalp EEG was 78% in 27 cases with structural lesions and 83% in the other 12 non-lesional cases. Epileptogenic zone estimated by MEG was within 2 cm area from encephalomalacia, and 50% focus localized by MEG were in the area adjacent to the pathological lesion, or in the contralateral area in the cortical dysplasia and hemisphere lesion group. Twenty-four out of 33 cases underwent surgical treatment after functional mapping by MEG. These cases had no further functional deficit.

Conclusion: MEG can localize interictal discharge and detect high frequency discharges non-invasively. MEG-based functional mapping has great benefit to protect eloquent cortical zone in epilepsy surgery.

P-A-14

Development of contralateral spike focus over years in a patient with cavernoma and medically intractable epilepsy

Yosuke Kakisaka 1), Nobukazu Nakasato 2, 3), Kazutaka Jin 4), Masaki Iwasaki 2), Hiroshi Shamoto 2), Akitake Kanno 3), Shigeru Tsuchiya 1),

1) Department of Pediatrics, Tohoku University Graduate School of Medicine, Sendai, Japan
2) Department of Neurosurgery, Kohnan Hospital, Sendai, Japan
3) Tohoku Ryogo Center, Kohnan Hospital, Sendai, Japan
4) Department of Neurology, Tohoku University Graduate School of Medicine, Sendai, Japan

Our recent MEG study revealed unique physiology of epilepsy with cavernoma: interictal spikes sources were localized not only near the lesion, but also in the remote area (Jin et al., in press). Here we present a case of medically intractable epilepsy with a cavernoma in which sequential MEG studies over 6 years have shown development of the contralateral spike focus. A 35-year-old man with a left insulo-frontal cavernoma suffered from complex partial seizures since his age of 22. His seizures became medically intractable at the age of 29, when the first MEG revealed small spikes localized near the lesion and in the ipsilateral temporal lobe. At the age of 33, his second MEG showed bilaterally independent spikes, in which current sources were estimated in the bilateral temporal lobes. In his third MEG at the age of 35, spike sources were estimated only in the contralateral temporal lobe, while the ipsilateral hemisphere had rhythmic slow waves only. We believe that the contralateral spike activity developed over time is due to propagated activity from the perilesional irritability that is too small to be detected, although the secondary epileptogenesis in the contralateral spike focus can not be denied completely.

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The effects of neuromuscular electrical stimulation in hemiplegia using magnetoencephalography

Kei Nakagawa 1), Takeshi Fushimi 1), Masahiko Fujimura 1), Yumi Kawahara 1), Koichiro Naminohira 1), Masamitsu Kanno 1), Abdellah Boulenouar 1), Akira Hasizume 2), Kaoru Kurisu 2), Louis Yuge 1)

1) Division of Bio-Environmental Adaptation Sciences, Hiroshima University, Hiroshima, Japan
2) Department of Neurosurgery, Hiroshima University, Hiroshima, Japan

It is important to evaluate central nerve activation not only noticeable improvement in rehabilitation medicine. We examined the effects of neuromuscular electrical stimulation (NMES) using magnetoencephalography in healthy subjects and patients with central nervous system disorder. We developed an ankle dorsiflexion movement device, which was limited performance to this active movement, and evaluated movement related cerebral magnetic fields (MRCF) and myoelectric potential before / after NMES. The amplitude of motor evoked field I (MEFI) tended to become larger after NMES. In addition, the latency during EMG onset and movement onset became shorter. These results suggested that NMES facilitated nerve activation.

Combined use of functional MRI, magnetoencephalography and near-infrared spectroscopy for identification of language dominance

Takahiro Ota 1), Kyousuke Kamada 1), Kensuke Kawai 1), Shigeki Aoki 2), Nobuhito Saito 1)

1) Department of Neurosurgery, The University of Tokyo, Tokyo, Japan
2) Department of Radiology, The University of Tokyo, Tokyo, Japan

Objective: One of the important priorities is to preserve language functions in neurosurgery. The Wada test is the gold-standard procedure to identify the language dominance, but is still invasive. It is, therefore, desirable to establish the reliable method to non-invasively visualize language functions. We applied three functional imaging techniques such as functional MRI (fMRI), magnetoencephalography (MEG), and near-infrared spectroscopy (NIRS), and found advantages and pitfalls of each modality to determine language lateralization.

Methods: We investigated 65 patients with brain lesions and language dominance was confirmed by the Wada test in 18 cases. All patients were asked to perform a letter-reading task for fMRI and MEG, and a word generation task for NIRS.

Results: Language dominance was determined in 94% of cases by combining three modalities. Functional MRI and NIRS were vulnerable in cases with severe brain edema or ischemic conditions. Patients with mental retardation or aphasia should be repeatedly studied. In some cases that had bilateral language dominance or were left-handed, the Wada test was carefully performed to confirm the special language distributions.

Conclusion: The results demonstrate that our non-invasive functional mapping would be promising and alternative to invasive procedures of the Wada test.
Gradual recovery from dyslexia and related serial magnetoencephalographic changes in the lexicosemantic centers after resection of a mesial temporal astrocytoma: case report

Taichi Kin, Kyousuke Kamada, Takahiro Ota, Kensuke Kawai, Nobuhiro Saito

Department of Neurosurgery, The University of Tokyo, Tokyo, Japan

Letter-perception centers are not held in a high regard as language-related cortices during planning of neurosurgical procedures, and there have been no reports suggesting cortical reorganization of reading ability. The authors describe a patient with a glioma in whom two letter-perception centers were successfully localized before surgery by performing magnetoencephalography (MEG) during reading tasks. Control MEG examinations of 15 healthy volunteers were also performed to assist in a careful interpretation of patient results. Although a radical resection of the mesial temporal glioma, which involved the left fusiform gyrus, caused severe dyslexia, the patient's impaired reading skills improved gradually during a 1-year postoperative period. In the meantime, the spared left superior temporal gyrus displayed an overshot recovery of MEG responses. During the postoperative period there was no obvious recovery in MEG signals and no compensatory activity in the contralateral fusiform gyrus. This case demonstrates that lexicosemantic centers involved in the reading process can be noninvasively localized using MEG and that the results obtained are highly reliable for surgical planning. The results of the repeated MEG reflected sequentially the patient's recovery from dyslexia. These MEG studies have been shown to predict preoperatively the risk of dyslexia and demonstrate its serial physiological recovery.

Presurgical mapping of paediatric motor function and structure using magnetoencephalography (MEG) and diffusion tensor imaging (DTI)

William Gaetz 1, 2), Elysa Widjaja 3), Sonya Bells 1), Conrad Rockell 1), James Drake 4), Hiroshi Otsubo 5), Douglas Cheyne 1), Elizabeth W. Pang 5), Donald Mabbott 1)

1) Program in Neuroscience and Mental Health, Hospital for Sick Children, Toronto, Canada
2) Department of Diagnostic Imaging, Hospital for Sick Children, Toronto, Canada
3) Department of Radiology, Hospital for Sick Children, Toronto, Canada
4) Department of Neurosurgery, Hospital for Sick Children, Toronto, Canada
5) Department of Neurology, Hospital for Sick Children, Toronto, Canada

Presurgical mapping of eloquent cortex enables resection of diseased neural tissue while minimizing new deficits. In the past, MEG mapping of motor cortex has yielded poor accuracy and reliability for clinical populations. However, recent advances in source localization using spatial filtering methods have provided accurate functional measures of motor cortex activity in patients. We used these new mapping methods in combination with DTI tractography to delineate motor cortex and associated white matter tracts for healthy children and patients. Subjects included 4 healthy children and 2 children who were surgical candidates for tumor resection. MEG mapping during right and left index finger movements to visual targets were used to localize the motor field accompanying movement onset. MEG activations were then used to seed probabilistic tractography. The motor field was consistently localized to the hand motor area of pre-central gyrus. Tractography revealed cortical-spinal tracts originating from the motor activations and descending through the medulla at the inferior boundary of the FOV. For patients there was evidence of tract displacement by the tumor. These novel findings confirm that combining noninvasive MEG and DTI methods can identify eloquent motor cortex and associated corticospinal tracts and provide important information for surgical guidance.
P-B-05

Somatosensory functional assessment in frontal lobe tumors by somatosensory evoked field

Daisuke Tsuchiya, Wataru Mouri, Kaori Sakurada, Takamasu Kayama

Department of Neurosurgery, Yamagata University School of Medicine, Yamagata, Japan

Purpose: The purpose of this study was to investigate the clinical usefulness of SEF in brain tumor.

Patients and Methods: SEF was measured in 10 gliomas and 5 metastatic brain tumors by whole head 306 channel MEG. The peak latency (N20m) and ECD moment (d/m) for the N20m were calculated. Sensory disturbance was examined. Brain edema and mass effect in postcentral gyrus were evaluated in FLAIR MRI.

Results: (i) Of all 15 cases, 4 cases showed significant delay of N20m and reduction of d/m. Sensory disturbance, edema and mass effect were observed in all 4 cases. (ii) In 3 cases, there was no significant delay of N20m but significant reduction of d/m. Although sensory disturbance and edema were not seen, mass effect was interestingly observed. (iii) No significant delay of N20m, reduction of d/m and sensory disturbance were seen in 8 cases. In 7 cases edema and mass effect were not found. However, one diagnosed as glioma showed edema and mass effect.

Conclusions: Results indicated that both N20m and d/m could be a good indicator of somatosensory function in brain tumors. d/m could be more useful if mass effect occurred by tumors.

P-B-06

VEF study in two surgical cases of occipital lobe lesions

Tohru Ohta 1), Naoki Higashiyama 1), Kenichi Shibata 1), Hiroyuki Kinouchi 2), Toshiharu Yanagisawa 1), Akira Suzuki 1), Masatake Takahashi 1), Toshio Sasajima 1), Kazuo Mizoi 1)

1) Department of Neurosurgery, Akita University, Akita, Japan
2) Department of Neurosurgery, University of Yamanashi, Kofu, Japan

We measured the pre and postoperative magnetic response to pattern reversal visual stimuli in two patients with occipital lobe lesion. Case 1, with left occipital AVM, had no visual disturbance in the conventional perimetry. He complained of right homonymous hemianopsia just after the operation, but recovered 5 days later. There was no visual disturbance in the conventional perimetry after 7 days of the operation. However, evoked responses in the pattern-reversal visual evoked magnetic field (VEF) were observed only in the right occipital lobe. Conventional perimetry has the disadvantage of being affected by fixation disparity, hence, pattern-reversal VEF makes it possible to evaluate visual performance and functional localization more objectively, quantitatively, and spatially. Case 2, with a right occipital huge meningioma, complained of blurred vision and left homonymous hemianopsia. Funduscopy and conventional perimetry showed a bilateral choked disc and left homonymous hemianopsia. Preoperative VEF demonstrated an evoked response with prolonged latency in the bilateral occipital lobe. Her visual function improved markedly soon after surgery. VEF after 6 months from surgery showed a shortening in the VEF latency. Further studies are required to clarify whether prolongation of VEF latency over some threshold brings about visual disturbance or not.
P-B-07

Local oscillatory changes related to the pattern reversal visual stimulation in the patients with a lesion in the optic pathway

Naoki Tani, Masayuki Hirata, Tetsu Goto, Satoru Oshino, Koichi Hosomi, Takafumi Yanagisawa, Haruhiko Kishima, Youichi Saitoh

Department of Neurosurgery, Osaka University, Osaka, Japan

Objective: The local oscillatory changes related to the visual stimulation were investigated in the patients with brain lesions affecting the optic pathway using synthetic aperture magnetometry (SAM).

Materials and Methods: Twenty-seven neurosurgical patients with brain lesions in the optic pathway and six healthy subjects participated in this study. Oscillatory changes induced by visual stimulation were analyzed with SAM. In the two cases with occipital tumor, the intraoperative recording of cortical visual evoked potential was performed to compare with the result of MEG.

Results: Event-related synchronisation (ERS) in the gamma band was strictly localized around the calcarine sulcus, most probably reflecting the primary visual cortex. In case the lesion-related infiltration, compression or edema affected the optic pathway, high gamma-ERS were sensitively attenuated in magnitude or shifted the location or frequency band. High gamma-ERS was significantly attenuated more severely in the patients with hemianopsia than in the patients without visual field disturbance. The cortical VEP showed the same pattern as MEG.

Conclusion: These findings are useful for the surgical planning in the patients with brain lesions affecting the visual pathway.

P-B-08

Clinical application of MEG: establishing an objective quantitation of curative effects for cervical spondylotic myelopathy

Naoki Higashiyama, Tohru Ohta, Kenichi Shibata, Taku Sugawara, Kazuo Mizoi

Division of Neurosurgery, Department of Neurology and Locomotor Science, Akita University, Akita, Japan

Our aim in this study was to establish an objective quantitation of the surgical effects for cervical spondylotic myelopathy with the aid of an advanced helmet-shaped, whole-head magnetoencephalography (MEG) system. In eight surgical cases of cervical spondylotic myelopathy, we measured the pre- and postoperative somatosensory evoked magnetic fields (SEFs) with median nerve and posterior tibial nerve stimuli, with particular emphasis on the first (1M) and second (2M) peaks. Both the peak latency and dipole intensity of 1M and 2M improved six months after surgery. The recovery of the dipole intensity was particularly satisfactory, recovering to where there was no significant difference in comparison with normal controls. In one case, although the preoperative 1M peaks of SEFs with median nerve stimuli were not identified, those did appear one month after surgery. The 2M peaks of SEFs were clearly identified in all measurements, and with time, latency shortened, dipole intensity increased. The results of 2M peak analyses of this patient correlated well with postoperative neurological improvement. Our results suggest that pre- and postoperative sequential analyses of 1M and 2M peaks may provide the criteria for curative surgical effects and prognosis prediction factors of cervical spondylotic myelopathy.
Ictal and interictal magnetoencephalogram of paroxysmal kinesigenic choreoathetosis

Keiko Yanagihara 1), Toshiyuki Mano 2), Katsumi Imai 3), Toshiki Yoshimine 4)

1) Osaka Medical Center for Maternal and Child Health, Izumi, Japan
2) Osaka Developmental Rehabilitation Center, Osaka, Japan
3) Hospital for Sick Children, Toronto, Canada
4) Department of Neurosurgery, Osaka University Graduate School of Medicine, Osaka, Japan

Paroxysmal kinesigenic choreoathetosis (PKC) is a rare disorder in childhood, showing frequent brief choreic or dystonic attacks just after starting some movements, and attacks are always preceded by sensory auras. There are many discussions whether PKC attacks are epileptic or not. Interictal and ictal EEGs are usually normal, and anti-epileptic drugs are quite effective in these cases. We analyzed MEG waves in a PKC patient in order to clarify whether attacks are epileptic seizures or not - especially to differentiate from seizures of secondary somatosensory cortex origin. Patient was a thirteen-year-old girl with daily PKC attacks. Her interictal EEGs showed no epileptic discharge. For recordings, MEG device was 64-channel whole head type, CTF, Canada. Detected attack was a slight dystonic movement in her left arm just after abnormal sensation in the same arm. MEG waves showed no epileptic discharges during ictal and interictal recordings. Somatosensory evoked field after median nerve stimulation showed no differences between both sides. PKC attack shows no evidence of epileptic seizure from magnetoencephalographic study.

MEG activities during a memory task in patients with early Alzheimer’s disease

Ryu Kurimoto 1), Ryuhei Ishii 1), Canuet Leonides 1), Koji Ikezawa 1), Michiyoh Azechi 1), Masao Iwase 1), Hiromitsu Kazui 1), Toshiki Yoshimine 2), Masatoshi Takeda 1)

1) Department of Psychiatry, Osaka University Graduate School of Medicine, Osaka, Japan
2) Department of Neurosurgery, Osaka University Graduate School of Medicine, Osaka, Japan

There are few reports on magnetoencephalography (MEG) in Alzheimer’s disease (AD). Maestú et al reported a decrease in the number of dipoles in the left parietal and temporal areas in AD during a memory task. In the present study, we compared the event-related desynchronization (ERD) during a memory task in AD and normal controls. Six patients with probable AD were selected according to NINCDS-ADRDA criteria (age: 75.5 ±6.0; mini-mental state examination: 22.0±2.5). We also selected ten normal control subjects (age: 72.6±6.2; mini-mental state examination: 28.2±1.6). MEG activities were recorded with a 64-channel whole head magnetometer in a magnetically shielded room. For data analysis, the spatial filter technique was used. The ERD in beta (15-30Hz) and gamma (30-80Hz) band was calculated and their current source densities were superimposed on the individual MRI image.
Sensory recognition mechanism in the congenital insensitivity to pain and anhidrosis patient: a magnetoencephalography study

Nobuyuki Matsuura 1), Toshiya Tomioka 2), Yohei Tamura 1), Yoshiyuki Shibukawa 3), Masuro Shintani 4), Tatsuya Ichinohe 1)

1) Department of Dental Anesthesiology, Tokyo Dental College, Tokyo, Japan
2) Department of Anesthesiology Faculty of Medicine, The University of Tokyo, Tokyo, Japan
3) Department of Physiology, Tokyo Dental College, Tokyo, Japan
4) Laboratory of Brain Research, Tokyo Dental College, Tokyo, Japan

Introduction: Congenital insensitivity to pain and anhidrosis (CIPA) is a rare inherited disease and is classified as a hereditary sensory and autonomic neuropathy type IV. The aims of this study were to record SEFs in CIPA patients and to compare sensory recognition mechanism with SEFs data of normal subjects, using electrical stimulation of peripheral nerve.

Methods: Subjects were six consensual CIPA patients. MEG recordings were obtained when the electrical stimulations were given on the skin of forearm. The conditions of stimulation were intensities 2.2 - 4.8 mA, duration 0.2 ms, interval 1000 ms, and analysis time -50 - +400 ms. One hundred trials were averaged in one session.

Results: Peak latencies of SEFs were recorded contralaterally at approximately 20, 40, 70 ms after the electrical stimulations. The Equivalent Current Dipoles (ECDs) with 20 ms were located in the region corresponding to contralateral primary somatosensory cortex (SI) area in all subjects.

Discussion: The data of SEFs were same as normal subjects. From the mentioned above results, it was suggested that sensory recognition mechanism through Aδ fiber of CIPA was similar to that of normal subjects.

Abnormal neural oscillatory activity to speech sounds in schizophrenia: an MEG study

Shogo Hirano, Toshiaki Onitsuka, Yoji Hirano, Toshihiko Maekawa, Choji Obayashi, Naoya Oribe, Shigenobu Kanba

Department of Neuropsychiatry, Graduate School of Medical Sciences, Kyushu University, Fukuoka, Japan

Schizophrenia impairs many cognitive functions, and abnormalities in language processing have been proposed as a base for this disorder. Recent study reported that different magnetoencephalography (MEG) patterns of the early evoked gamma band response (eGBR) to speech and non-speech sounds evidenced a fast mechanism for the representation of speech sounds in humans. We hypothesized that schizophrenics would show abnormal neural oscillatory activity as measured by eGBR to speech and non-speech sounds, and that this abnormal oscillatory activity would be associated with the severity of auditory hallucinations. MEG responses to speech and non-speech sounds in twenty patients and 23 control subjects were recorded, and time-frequency (TF) power at 20-45 Hz was calculated. In 0-50 ms, patients showed significantly reduced TF power and, in 100-150 ms, significantly larger TF power to speech sounds in left hemisphere. Additionally, there was a significant negative correlation between TF power of the gamma band in 100-150 ms to speech sounds in left hemisphere and the scores on auditory hallucination. These results suggested that schizophrenics showed deficits in a fast mechanism for the representation of speech sounds specifically in left hemisphere, and the abnormal neural circuit function in speech recognition may be an underlying pathophysiology of schizophrenia.
Dysfunction of visuomotor integration in patients with temporomandibular disorders

Yoshiyuki Shibukawa 1,2), Tetsuya Ishikawa 1), Yutaka Kato 3), Zhen-Kang Zhang 4), Ting Jiang 5), Masuro Shintani 1), Masaki Shimo 6), Toshifumi Kumai 7), Masakazu Tazaki 2), Motoichiro Kato 3), Yoshio Nakamura 1)

1) Laboratory of Brain Research, Oral Health Science Center, Tokyo Dental College, Tokyo, Japan
2) Department of Physiology, Tokyo Dental College, Tokyo, Japan
3) Department of Neuropsychiatry, Keio University School of Medicine, Tokyo, Japan
4) Department of Maxillofacial Surgery, Stomatology School of Peking University, Beijing, China
5) Department of Prosthetic Dentistry, Stomatology School of Peking University, Beijing, China
6) Department of Pathology, Tokyo Dental College, Tokyo, Japan
7) Department of Oral Physiology, Matsumoto Dental University, Shiojiri, Japan

To examine possible modification of cortical machinery in patients of temporomandibular disorders (TMD), we compared cortical neuromagnetic signals between healthy subjects and TMD patients while they were carefully observing the video-clips of jaw-opening movements performed by another person. During the movement observation task in the healthy subjects, we found cortical activation in the following sequence: 1) the occipitotemporal region near the inferior temporal sulcus (human homologue of MT/V5 in monkeys), 2) the inferior parietal cortex (IPC), and 3) the anterior part of the inferior-lateral precentral gyrus (PrCG). In the patients, however, we found deficit or marked attenuation of the magnetic responses in the PrCG and IPC, while the activity of the MT/V5 showed no differences from that in the healthy subjects. In addition, we could not find any differences in cortical responses between healthy subjects and the patients when they were observing palm-opening movements. This indicates that cortical dysfunction associated with jaw-movement observation is a specific phenomenon in the TMD patients. The present study provides new neuropathological evidence that TMD patients exhibit cortical dysfunction of visuomotor integration mechanisms during motor observation.
Pathological high frequency oscillations in writer’s cramp

Zoe F. Cimatti 1,2), Denis P. Schwartz 3), Frederic Bourdain 4), Sabine Meunier 5), Jean Pierre Bleton 6), Marie Vidailhet 4,7), Line Garnero 2)

1) Pierre and Marie Curie University, Paris, France
2) Cognitive Neurosciences and Brain Imaging Laboratory, Paris, France
3) MEEG Center, Pitié Salpetrière Hospital, Paris, France
4) Neurology Department, Saint Antoine Hospital, Paris, France
5) Physiology and Physiopathology of Motor Control in Humans Unit, Paris, France
6) Neurology Department, Raymond Garin Center, Sainte Anne Hospital, Paris, France
7) Experimental Neurology and Therapeutics Unit, Paris, France

Objective: To determine if high frequency oscillations (HFO) patterns are modified in patients with focal dystonia such as writer’s cramp (WC).

Background: HFO are thought to reflect activity of intracortical neurons bursting at high frequencies. HFO might play a role in processing somatosensory inputs. Thus, we studied HFO in dystonia, where somatosensory processing is disrupted. Indeed, patients with WC experience motor symptoms in the upper limb during writing, but somatosensory dysfunctions have been largely documented.

Methods: Using MEG, we recorded N20m and HFO evoked by 800 median nerve stimulations of the dominant and non-dominant hands in 13 patients with WC and 11 healthy subjects. We computed power measures using a time-frequency analysis.

Results: ANOVA test shows that in patients, when evoked in the dominant/symptomatic hand, HFO power is strongly reduced. On the contrary, when evoked in the non-dominant/asymptomatic hand, HFO power is similar to controls.

Conclusions: In healthy subjects, HFO could result from the spatiotemporally synchronized activity of several populations, possibly GABAergic. We suggest that in WC, decreased HFO power could sign for the expression of the disease, due to desynchronized bursting of cortical neurons assemblies. This could reflect an abnormality in sensory processing in the somatosensory cortex.
P-C-01

Effects of generalized epileptic discharges on MEG coherences of frontal area in idiopathic generalized epilepsy

Kotaro Sakurai 1), Youji Takeda 1), Tsugiko Kurita 1), Tsukasa Koyama 1), Fumiya Takeuchi 2)

1) Department of Psychiatry and Neurology, Hokkaido University, Sapporo, Japan
2) Department of Health Science, Hokkaido University, Sapporo, Japan

Objective: To assess the effects of generalized epileptic discharges on MEG coherences of frontal area in idiopathic generalized epilepsy (IGE).

Methods: Interictal MEG of five untreated IGE patients were recorded for 30 minutes. 14 diffuse spike-wave complexes (DSWC) that were recorded during wakefulness and lasting less than 2 seconds were selected. Before and after DSWC, inter- and intra-hemispheric coherences of frontal area were calculated in 12 frequency bands.

Results: Inter-hemispheric coherence was significantly increased after DSWC in three beta bands (18.8-21.1Hz, 21.1-23.5Hz, 23.5-25.8Hz), and significantly decreased in one alpha band (9.4-11.7Hz). Left intra-hemispheric coherence was significantly decreased in one beta band (25.8-28.2Hz).

Conclusions: Our results indicated that DSWC have powerful hypercoherent effects on the beta range between hemispheres.

P-C-02

Analysis of interictal high frequency oscillations using gradient magnetic-field topography on magnetoencephalography in patients with intractable epilepsy

Koji Iida 1), Hiroshi Shirozu 1), Akira Hashizume 1), Yoshihiro Kiura 1), Ryosuke Hanaya 1), Kaoru Kurisu 1), Kazunori Arita 2), Hiroshi Otsubo 3)

1) Department of Neurosurgery, Hiroshima University, Hiroshima, Japan
2) Department of Neurosurgery, Kagoshima University, Kagoshima, Japan
3) Department of Neurology, The Hospital for Sick Children, Toronto, Canada

Introduction: Intracranial EEG recordings showed interictal high frequency oscillations (HFOs) in the epileptogenic zone. We developed gradient magnetic-field topography (GMFT) for magnetoencephalography (MEG) to visualize the dynamic change of gradient magnetic fields for interictal epileptic discharges. We applied GMFT to analyze the interictal HFOs recorded by MEG in patients with intractable neocortical epilepsy.

Methods: Six patients underwent MEG studies with a whole-head planar gradiometer Neuromag system. We selected 30-70 Hz frequency band to analyze HFOs. GMFT projected topographies of HFOs over individual brain surface MR images. The distribution of HFOs on GMFT was compared with those of equivalent current dipole (ECD) and of intracranial EEG.

Results: Intracranial EEG showed the epileptogenic zone in frontotemporal (2), temporal (2), central (1) and mesial occipital (1) regions. Five patients had single clustered ECDs and one had scattered ECDs. Three patients had the interictal HFOs in the frontal, temporal, and parietal region each. The distributions of HFOs on GMFT were partially overlapped with the clustered ECDs and the epileptogenic zone. Four patients became seizure free and two had > 90 % seizure reduction.

Conclusions: GMFT revealed the distribution of interictal HFOs correlating with the epileptogenic zone in neocortical epilepsy.
P-C-03

Spectral statistics of correlation matrices from MEG signals in epilepsy

Maribel Pulgarin-Montoya ¹), Will Woods ¹), Aziz Asghar ²), Gary Green ¹)

1) York Neuroimaging Centre, University of York, York, United Kingdom
2) Hull-York Medical School and Department of Biological Sciences, University of Hull, Hull, United Kingdom

We propose the use of a method based on the equal-time correlation matrix as a sensitive detector for correlations in the analysis of MEG data signals. The key characteristics underpinning this method is that detailed information about the correlation structure of the multivariate data set is imprinted into the dynamics of the eigenvalues and into the structure of the corresponding eigenvectors. These methods have previously been applied to EEG signals and provide information regarding dynamics of correlations/decorrelations [1, 2]. An analysis is presented of magnetoencephalographic recordings using spectral statistics of correlation matrices from ongoing resting activity in both healthy participants and in patients with epilepsy. In addition, results are presented using these analysis tools in healthy subjects performing a cognitive task. We illustrate the potential of this method to characterize dynamic features of ongoing activity in epilepsy and more generally, to investigate dynamic changes of brain activity.


P-C-04

Identifying epileptic abnormality with volumetrically reconstructed default mode of brain

Jing Xiang, Yinhong Liu, Yingying Wang, Hisako Fujiwara, Nat Hemasilpin, Ki Lee, Douglas Rose

MEG Center, Department of Neurology, Cincinnati Children's Hospital Medical Center, Cincinnati, USA

Our previous magnetoencephalography (MEG) study has demonstrated that the epileptic brain is associated with abnormal high-frequency neuromagnetic signals (>100 Hz). This study was to develop a new technique for quantitative assessment of the high-frequency neuromagnetic abnormality in epilepsy by comparing default mode of the normal brain and the epileptic brain. MEG data were recorded with a 275-Channel MEG system. The sampling rate of data acquisition was 4000 Hz. All MEG data were transformed from time-domain to frequency-domain with S-transform. Focal increases of spectral power were clearly identified in color-coded spectrogram. The default mode of the brain was volumetrically reconstructed with a new systematic approach. The preliminary results have demonstrated that epilepsy is associated with abnormal default mode of brain in multiple frequency bands. Focal increases of spectral power in high-frequency magnetic signals were identified in all patients (> 100 Hz). We consider that quantitative comparison of default mode of brain may open a new window for identification of epileptic abnormality.
P-C-05

Localization of ictal onset neuromagnetic oscillations using a spatiotemporal beamformer

Ismail S. Mohamed 1), William Gaetz 2), Katsumi Imai 3), Carter O. Snead III 3), Douglas O. Cheyne 2), Hiroshi Otsubo 3)

1) Department of Pediatrics, University of Calgary, Calgary, Canada
2) Neuromagnetic Imaging Laboratory, University of Toronto, Toronto, Canada
3) Department of Pediatrics, University of Toronto, Toronto, Canada

Purpose: To evaluate the utility of a spatiotemporal beamforming approach (erSAM) in the localization of ictal MEG recordings in pediatric epilepsy.

Methods: MEG recordings were obtained in two patients with intractable epilepsy evaluated for epilepsy surgery. We marked the ictal onset point as represented by the first well defined rhythmic discharge observed on the MEG recordings. The erSAM algorithm was used to compute the mean power of the whole brain over a time frame of 200 ms from the identified ictal onset.

Results: Seven electrographic seizures were captured during the MEG recording in one patient. erSAM peak activation was identified in the right hippocampus in four seizures and more posterior in the right basal temporal areas in the other three (patient 1). The patient subsequently underwent right anterior temporal lobectomy. In patient 2, one electroclinical seizure was captured. Ictal onset localization by erSAM correlated with invasive EEG recordings and was localized to the margin of previous failed resection.

Conclusion: We present a new approach for source localization in ictal MEG data. The approach allows accurate source localization of low amplitude discharges seen at ictal onset and can construct time course data of neuronal sources involved in seizure onset and propagation.

P-C-06

Integration of dipole localization with MEG for intraoperative neuronavigation system

Yohei Yokoyama 1), Nobuhiro Mikuni 1), Takashi Nagamine 2), Nobuyuki Mori 3), Yukio Miki 3), Hidenao Fukuyama 2), Nobuo Hashimoto 1)

1) Department of Neurosurgery, Kyoto University Graduate School of Medicine, Kyoto, Japan
2) Human Brain Research Center, Kyoto University Graduate School of Medicine, Kyoto, Japan
3) Department of Diagnostic Imaging and Nuclear Medicine, Kyoto University Graduate School of Medicine, Kyoto, Japan

Purpose: We investigated the significance of integration of MEG ECDs for neuronavigation system in surgical treatment of intractable epilepsy.

Methods: In 4 cases of intractable epilepsy in whom focal resection was planned, we recorded SEF and epileptic discharges on spontaneous MEG and then integrated their ECDs for neuronavigation system. MEG ECDs were compared with other modalities (conventional MRI, DTI tractography) and intraoperative ECoG. Functional mapping was performed with cortical electric stimulation in two cases.

Results: In all the cases, ECDs estimated from epileptic discharges were clustered on MEG and were also corresponded to focus localization by intraoperative ECoG. Almost all the epileptic discharges disappeared after focus resection, and there was no convulsive attack on postoperative state. In 2 cases with the lesion close to eloquent area, epileptogenic cortices were removed without neurological deficits.

Conclusions: Integration of ECDs for neuronavigation system is useful to visualize the epileptogenicity and function of cortices pre and during epilepsy surgery.
Value of interictal MEG spikes in guiding placement of ECoG electrodes

Eun Young Kim, June Sic Kim, Chun Kee Chung

MEG center, Seoul National University Hospital, Seoul, Korea

Background: In the preoperative assessment of epilepsy, accurate localization of epileptogenic zone could not be overemphasized. ECoG has been a gold standard for localization of epileptogenic zone. However, ECoG has inherent selection bias because of its limited coverage over brain. On the other hand, MEG sensors could cover whole brain. We sought for the value of MEG in guiding placement of ECoG electrodes.

Materials and Methods: Between July 2005 and January 2007, 25 patients who underwent both MEG and ECoG were included. MEG was performed with 306 channels whole head MEG system. We used MEG interictal spikes to guide placement of ECoG electrodes.

Result: Combined use of MEG and ECoG allowed 18 of 25 (72%) patients seizure free postoperatively. Five or more MEG interictal spikes were detected in 16 of the 25 patients. In 11 of 16 cases, ECoG ictal onset zone was in the same lobe as the epileptic region determined by MEG interictal spikes at the lobe level.

Conclusion: The present study supports MEG is useful to guide placement of ECoG electrodes.

Magnetoencephalographic analyses for interictal rhythmic spikes in patients with symptomatic localization related epilepsy induced by circumscribed cortical lesions using time-frequency analysis

Keitaro Sueda 1), Fumiya Takeuchi 2), Hideaki Shiraishi 1), Shinji Nakane 3), Naoko Asahina 1), Kazuyori Yagyuu 1), Shinobu Kohsaka 1), Shinji Saitoh 1)

1) Department of Pediatrics, Hokkaido University Graduate School of Medicine, Sapporo, Japan
2) Department of Health Science, Hokkaido University School of Medicine, Sapporo, Japan
3) Division of Magnetoencephalography, Hokkaido University Hospital, Sapporo, Japan

Purpose: To analyze the magnetoencephalographic (MEG) interictal rhythmic spikes which cannot be examined by single equivalent current dipole (ECD), we tried to use time-frequency analyses and evaluate the relationship between MEG findings and intraoperative electrocorticographic findings.

Methods: We studied 3 children with symptomatic localization related epilepsy who had circumscribed cortical lesions (dysembryoplastic neuroepithelial tumor 1, and focal cortical dysplasia 2) by 204 channel helmet-shaped MEG (Vector View system, Elekta Oy, Sweden) with 600Hz sampling rate. We used short-time Fourier transform (STFT) and assessed the specific frequency spectrum. Aberrant area was superimposed to 3DMRI and described as moving images.

Results: A DNT patient showed 20-25 Hz rhythmic spikes in the vicinity of the tumor. FCD patients had 15-20 Hz rhythmic spikes just upon the lesions. The findings were well correlated to those of the intraoperative electrocorticographic findings. The patients became seizure free after the surgery and their MEG findings disappeared.

Conclusion: Frequency analyses of rhythmic spikes on MEG by STFT are useful to demonstrate the distribution of the epileptogenic area of the patients with symptomatic localization related epilepsy induced by circumscribed cortical lesions.
Characteristics of neuronal activation in the primary sensorimotor cortex under chronic ischemia and its change through surgical intervention

Takenori Akiyama 1), Kenji Hiraga 1), Kazunori Akaji 1), Yoshio Tanizaki 1), Masahito Kobayashi 2), Takayuki Ohira 2)

1) Department of Neurosurgery, Mihara Memorial Hospital, Isesaki, Japan
2) Department of Neurosurgery, Keio University, Tokyo, Japan

Object: Cascades of neuronal activation might be disturbed under cortical ischemia causing hemodynamic ischemic attack. We explored activation signals in and around the primary motor cortex in patients with severe cervical IC stenosis using multimodal functional studies and analyzed influence of cortical ischemia on activation signals.

Methods: Patients with severe cervical IC stenosis were enrolled in this study. Activation signals in and around primary sensorimotor cortex, following motor and sensory stimulation, were recorded by magnetoencephalography (MEG), functional MRI (fMRI) and functional near-infrared spectroscopy (fNIRS). Patients who received surgical intervention (CEA / CAS) were examined again after surgery.

Results: Various abnormalities such as changes in latency or dipole moment in MEG, negative BOLD in fMRI or steal phenomenon in fNIRS were observed. Surgical intervention affected these signals in some cases.

Conclusion: Cortical ischemia has some influence on activation pattern in the functional cortex and surgical intervention can modulate the altered activation pattern.

Analysis of magnetoencephalography for cerebral ischemia using spatial filter techniques: comparison of adaptive beamformer with sLORETA

Naohiro Tsuyuguchi 1), Yuzo Terakawa 1), Yoshihito Shigihara 1), Shinichi Sakamoto 1), Kenji Ohata 1), Hiroaki Tanaka 2)

1) Department of Neurosurgery, Osaka City University Graduate School of Medicine, Osaka, Japan
2) MEG Center, Yokogawa Electric Corporation, Kanazawa, Japan

Many reports show abnormal brain activity of EEG in cerebral ischemic lesion. Especially delta wave appears in the severe damaged brain. However, there are few MEG studies about spontaneous magnetic field in cerebral infarction. Some papers showed the relationship between penumbra area and theta activity. We evaluate low frequency brain activity by using spatial filtering techniques, and compare adaptive beamformer (ABF) with non-adaptive analysis (sLORETA). Ten patients with cerebral vascular diseases who had main branch occlusion or stenosis underwent MEG and SPECT or PET. In 7 cases, we found slow waves in low CBF lesion by ABF and sLORETA. The results of sLORETA fit in the ischemic area better than ABF. However, we could not point out the difference between delta and theta activity. sLORETA is useful method for analyzing slow wave activity in cerebral ischemic lesion.
P-C-11

Magnetoencephalography as a prognostic tool in acute monohemispheric stroke

Franca Tecchio 1), Doriani Landi 2), Patrizio Pasqualetti 3), Claudia Altamura 2), Francesco Tibuzzi 3), Carlo C. Quattrocchi 2), Filippo Zappasodi 1), Fabrizio Vernieri 2), Vittorio Pizzella 4), Paolo M. Rossini 2)

1) Institute of Sciences and Technologies of Cognition, National Research Council, Rome, Italy
2) Università Campus Bio-Medico, Rome, Italy
3) Associazione Fatebenefratelli per la Ricerca, Rome, Italy
4) Department of Clinical Sciences and Bioimaging, University of Chieti, Chieti, Italy

The clinical outcome of an ischemic stroke is highly variable, despite similar onset symptoms and lesion characteristics. A previous report by ours (Tecchio et al. J Neurol 2007) showed that a neurophysiological evaluation performed in acute phase by MEG could predict clinical outcome in patients affected by a monohemispheric stroke in the middle cerebral artery territory. The aim of the present study is to confirm these results in a new independent group of patients. Clinical score and MEG parameters were collected from 27 patients within 10 days from symptoms onset (T0). Magnetoencephalography parameters as evoked by sensory stimuli and at rest were evaluated in the affected (AH) and the unaffected (UH) hemisphere. The clinical status was reassessed in the stabilized phase (T1, median 7.6 months). Multiple multinomial logistic regression confirmed previous findings, i.e. that UH delta band absolute powers predicted clinical outcome at T1, with higher delta band powers associated with worse long term recovery. This remained an independent prognostic factor also after taking into account the brain MRI/CT data. Taking together the present group and previous group (total of 59 patients), a honed estimate of the UH delta band power cut-off was obtained, maximizing both sensitivity and specificity of the prediction.

P-C-12

Altered visual processing in migraine patients with persistent visual aura

Wei-Ta Chen 1, 2, 3), Yung-Yang Lin 1, 3, 4, 5), Shuu-Jiun Wang 1, 3), Jong-Ling Fuh 1, 3), Zin-An Wu 1, 3)

1) Neurologic Institute, Taipei Veterans General Hospital, Taipei, Taiwan
2) Institute of Neuroscience, National Yang-Ming University, Taipei, Taiwan
3) Department of Neurology, National Yang-Ming University, Taipei, Taiwan
4) Department of Medical Research and Education, Taipei Veterans General Hospital, Taipei, Taiwan
5) Institute of Physiology, National Yang-Ming University, Taipei, Taiwan

Persistent aura without infarction is a rare but well recognized complication of migraine with unknown pathomechanism. We recruited six of these patients (5F1M, age 42.8 ± 11.6) to find if there exists any neurophysiologic aberrancy pertinent to their unique visual phenomenon. Each subject underwent magnetoencephalographic recording with the right eyes covered and the left eye stimulated by left hemi-field checkerboard reversals (1 reversal/s). Four check sizes (120, 60, 30, 15 minutes of arc (°)) were used in separate experimental sessions, and 5 consecutive blocks, 50 epochs each, were obtained for each session. We used equivalent current dipole modeling to analyze the P100m responses for each block and for each session, as the five consecutive blocks lumped together. Data comparison with a group of 16 controls (12F4M, age 37.2 ± 11.4) shows the P100m of the patients peaked earlier (90.7 ± 8.6 vs. 99.4 ± 1.6 ms, p=.020) when elicited by 120’ checks. In the sessions of 60’ checks, the P100m amplitude ratio of the last in relation to the first block was higher in the patient group (1.2 ± 0.1 vs. 1.0 ± 0.2, p=.032). Other comparisons including P100m amplitude and localization were comparable between groups. Our findings suggest an abnormal visual contrast processing in these patients, especially in low spatial frequencies.
Proposition of an MEG phantom as the evaluation standard

Gen Uehara 1), Isao Hashimoto 1), Masato Yumoto 2), Hiroaki Tanaka 3), Tomoya Kimura 3), Toshimichi Narita 3), Masakazu Miyamoto 1), Yoshiaki Adachi 1)

1) Kanazawa Institute of Technology, Kanazawa, Japan
2) The University of Tokyo, Tokyo, Japan
3) Yokogawa Electric Corporation, Kanazawa, Japan

MEG phantoms with saline water, as a practical realization of the Sarvas model, have been used to evaluate the accuracy of magnetic field measurement by MEG systems as well as to confirm the validity of the algorithm for magnetic source analysis. But there are several concerns such as that the mechanical accuracy is hard to achieve, the linear current drive is also hard to achieve, and that the electrode quality degrades easily. On the other hand, the "dry phantom" proposed by Ilmoniemi et al., which is an isosceles-triangle coil with an infinitely small base, is free from these concerns and is a promising candidate for the standard. We propose the Ilmoniemi type phantoms with 5-mm base isosceles-triangle coils as the evaluation standard for MEG systems. First, we designed the parameters for a 3-dimensional phantom with 34 pairs of orthogonal oriented dipoles and then fabricated a 2-dimensional version with 8 pairs to test the feasibility of this phantom with a whole head MEG system. Reasonable results were obtained for the estimation errors of the position and the moment of the dipoles. Further improvement of machinery precision may lead to realization of the evaluation standard for MEG systems.
P-D-01

Modulation of auditory evoked responses to chords unfolded in musical sequence

Asuka Otsuka, Yuji Tamaki, Shinya Kuriki

Research Institute for Electronic Science, Hokkaido University, Sapporo, Japan

Amplitude of auditory-evoked fields (AEF), N1m and P2m responses, reflects acoustic properties of input sounds and also are modulated by endogenous factors such as attention. In order to investigate the effect of musically-induced attentional modulation, we measured AEF elicited by chords that were unfolded to form a musical sequence. In the first experiment for musicians, the amplitude of N1m/P2m to the last chord of 4- and 5-chord sequences was enlarged when the sequence ended authentically. The second experiment which examined the responses of musically non-experienced subjects to 4-chord sequences with authentic or ambiguous endings also showed a significant difference between the last two chords, with the forth chord elicited larger responses than the third chord. The amplitude of AEF did not differ between the two control chords that were acoustically the same as the third and forth chords but presented alternatively without musical context. Taken together, the significant enlargement of AEF to the last chord in the sequences is suggested to reflect the modulation of the auditory cortical activity by attention associated with musical progression. Such examination of auditory attentional effects in musical domain might be of clinical importance in diagnosis of auditory function.

P-D-02

Magnetic brain activity patterns in men and women according to motivated attention concept

Cristina Saugar, Stephan Moratti, Tomas Ortiz, Santiago Fernández

MEG Center Dr. Perez Modrego, Complutense University of Madrid, Madrid, Spain

According to Langs concept of motivated attention, we present different brain activation patterns of men and women observing both high arousing (pleasant and unpleasant) and low arousing images (neutral) using magnetoencephalography. We report subjective ratings and heart rate changes for each condition. The sources of brain activation were estimated with the minimum norm technique. Subjects showed more activation in right frontoparietal regions of the brain, when high arousal images were presented. This pattern was more pronounced in women than in men, i.e. women demonstrated more brain reactivity for high arousing stimuli. Our results show that high arousing pictures activate a frontoparietal attentional network possibly guiding information intake of biologically significant stimuli. This network seems to be more reactive for women than for men with respect to emotional stimuli.

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Eye-gaze and spatial attention: spatio-temporal localisation with MEG

Yoko Nagata, Sarah J. Bayless, Travis Mills, Margot J. Taylor

Research Institute and Department of Diagnostic Imaging, The Hospital for Sick Children, Toronto, Canada

Another person's eye gaze often triggers our attention such that we follow their direction of gaze. We investigated how the neural mechanisms for processing eye-gaze and spatial attention interact using magnetoencephalography. In a cueing paradigm a face was presented centrally with, left or right averted eye-gaze serving as the directional cue in the eye-gaze condition. In the peripheral condition, the face with a straight gaze was presented with a small cue stimulus appearing on the left or right of the face. Cue validity was 50%. Event-related beamforming was used to calculate source power at peak latencies following cue and target onsets. Spatial localisation indicated that different brain regions were recruited, while the networks engaged in the two conditions had the same temporal patterns. The processing of eye-gaze produced more focal brain activation than the exogenous cues. At 136 ms after target onset, activation in the temporoparietal junction, inferior frontal gyrus and precuneus, all lateralized in left hemisphere, were stronger in invalid than in valid trials. The fusiform was activated in the right hemisphere at this latency, across all conditions. We suggest that attentional processing was maximal in the left hemisphere, as the right hemisphere was engaged in processing the gaze information.

Magnetoencephalographic determination of hemispheric dominance for language and language specific areas with minimum L1 norm current estimate

Kenichi Shibata, Tohru Ohta, Naoki Higashiyama, Toshio Sasajima, Kazuo Mizoi

Department of Neurosurgery, Akita University, Akita, Japan

This magnetoencephalographic study was planned to evaluate the individual hemispheric dominance for language and the language specific cortical areas by using minimum L1 norm current estimate (MCE). After binaural auditory pure tone cue stimulus, the subjects generated a noun mentally one by one according to "SHIRITORI". The evoked MEG responses were on-line averaged and analyzed with software MCE. The dipoles on both perisylvian cortices over 3.5 nAm signal intensity were adopted as language-related significant evoked responses. In auditory evoked magnetic fields, the prominent responses about 100 ms after cue stimulus onset, were seen on bilateral auditory cortex in all subjects. Thereafter, the significant responses were seen on the left perisylvian area including a part of the superior and inferior temporal gyrus, inferior frontal gyrus, and the superior frontal gyrus. The latencies and durations of the averaged responses of those areas had significant variance between each subjects. The MEG mapping technique using MCE can reveal the hemispheric dominance for language and language-related regions within it. MEG-derived language maps and their time courses in word generation are slightly different across individuals. One of the possible explanations for such an individual variance is that various time courses may occur from repetition priming effect. Another is that the time required for mental noun generation may vary in each individual, as well as in each acquisition. Further refined paradigm optimized for the MEG mapping technique would clarify the spatiotemporal neural mechanisms in word generation.
P-D-05

Time-frequency analysis for prediction of language dominant hemisphere in Elekta-Neuromag neuromagnetometer system

Akira Hashizume, Kaoru Kurisu, Koji Iida, Ryosuke Hanaya, Hiroshi Shirozu

Department of Neurosurgery, Hiroshima University, Hiroshima, Japan

Hirata et al. reported that silent naming visual task suppressed spontaneous neuromagnetic activity in the 8 to 50 Hz range and the laterality of stronger suppression in the inferior frontal gyrus region was congruent with the result of the Wada test in 95% of patients (Neuroimage 2004). However, users of Elekta-Neuromag neuromagnetometer do not benefit from this report because reconstruction of neuromagnetic recordings with a spatial filter, synthetic aperture magnetometry (SAM) is not available. Instead of analysis based on SAM, we explored time-frequency analysis in each sensor and simply projected representative sensor signals over individual brain surfaces in our previously reported way (Brain Res 2007). Event-related desynchronization and synchronization were observed in occipital and temporal lobes, which suggest conventional event-related fields of calcarine cortices and fusiform gyri. When focusing on frequency oscillation of inferior frontal gyrus, desynchronization of alpha and beta band were stronger in language dominant hemisphere predicted by Wada test. In addition, our method could output results quite quickly because of no necessity of conductor model assumption, calculation of lead-field matrices, and establishment of a spatial filter. In conclusion, our method can be handy substitute for determination of language dominance with SAM.

P-D-06

Volumetric localization of language cortex with high-frequency neuromagnetic signals

Jing Xiang, Yinghong Liu, Yingying Wang, Jennifer Vannest, Anna Byars, Douglas Rose

MEG Center, Department of Neurology, Cincinnati Children's Hospital Medical Center, Cincinnati, USA

Our previous magnetoencephalography (MEG) study has demonstrated that visually presented words evoke neuromagnetic signals at a frequency range of 60-125 Hz. This study was to develop a new technique for volumetric localization of language areas using high-frequency magnetic signals (HFMS). The stimuli consisted of 110 words. The words were presented both visually and auditorily. Nine healthy volunteers (all right-handed) were studied with a 275 channel MEG system. The sampling rate of data acquisition was 6000 Hz. All MEG data were transformed from time-domain to frequency-domain with S-transform. The source locations were estimated with a new systematic approach. Focal increases of spectral power were clearly identified in color-coded spectrogram from 1 to 800 Hz. The frequency range of focal increase of spectral power was changing with latency. All subjects showed strong neuromagnetic activation from the bilateral occipital, left posterior temporal and the left inferior frontal regions in a latency of 200-600 ms. Our preliminary results have demonstrated that the new method developed in this study could detect focal increases of spectral power in HFMS (> 100 Hz). We consider that HFMS may open a new window for language mapping.
P-D-07

Movement related cerebral fields following forearm pronation in normal and patients with CNS disorders

Takeshi Fushimi 1), Kei Nakagawa 1), Masahiko Fujimura 1), Yumi Kawahara 1), Koichiro Naminohira 1), Masamitsu Kanno 1), Abdellah Boulenouar 1), Akira Hasizume 2), Kaoru Kurisu 2), Louis Yuge 1)

1) Division of Bio-Environmental Adaptation Sciences, Hiroshima University, Hiroshima, Japan
2) Department of Neurosurgery, Hiroshima University, Hiroshima, Japan

Most studies of movement related cerebral fields (MRCF) use finger tapping or wrist flexion task in generally. In these studies only normal subjects are used, because it is difficult to measure in patients with central nervous system (CNS) disorders. We tried to measure MRCF of patients with mild hemiparesis by using a forearm pronation device which easily detects active movement onset and can perform constant movement (range of motion was 0 to 30 degree). After 30 degree movement, forearm was passively returned to start position. Measurement was taken in both forearms respectively. Data was estimated by an equivalent current dipole model and spatial filter using sLORETA. In normal subjects, motor evoked field I (MEFI) appeared around movement onset. This component was located in the sensorimotor cortex contralateral to the movement. In patients, interhemispheric asymmetries between affected and non-affected side were considered.

P-D-08

Usefulness of spatial filter on the pain perception: an MEG study

Atsuo Yoshino 1), Akira Hashizume 2), Kazuhiro Shishida 1), Keiichi Onoda 1), Shinpei Yoshimura1), Yoshie Miyake 1), Akiko Kinoshita 1), Hidehisa Yamashita 1), Yasumasa Okamoto 1), Kaoru Kurisu 2), Shigeto Yamawaki 1)

1) Department of Psychiatry, Hiroshima University, Hiroshima, Japan
2) Department of Neurosurgery, Hiroshima University, Hiroshima, Japan

Objective: There have been numerous studies about the mechanism of pain perception with magnetoecephalography (MEG). However, most of these studies have used dipole estimation for localization of the source current, which requires a priori assumptions of number of sources or sensor selection. We investigated the temporal and spatial dynamics of pain perception using MEG and spatial filter, which does not need these arbitrary assumptions.

Methods: Painful stimuli were delivered on the left forearm by electric pulses. As non-painful stimuli, we also used electrical stimulation of the median nerve. The data of magnetic response were analyzed using the standardized Low Resolution Brain Electromagnetic Tomography method (sLORETA). We transformed these data into whole-brain normalization by using Statistical Parametrical Mapping 5 (SPM5, Wellcome Department, U.K.), and analyzed statistically.

Results: The temporal and spatial dynamics of pain perception were mainly shown in the bilateral secondary somatosensory cortex. Further, some differences between painful and non-painful stimuli were observed in the amplitudes and the locations of the sensory evoked field.

Conclusion: The brain activity observed in the present study is supposed to be similar to the previous neuroimaging findings. It is considered that MEG using spatial filter is useful for the research of pain perception.
P-D-09

Characteristics of somatosensory evoked field for tactile finger stimulation

Maaya Orii, Masahito Kobayashi, Takayuki Ohira

Department of Neurosurgery, Keio University, Tokyo, Japan

Background and Objective: It has been difficult to record somatosensory evoked fields by tactile stimulation because it is troublesome to determine a stimulation onset precisely.

Subjects and methods: Eleven healthy volunteers were studied by a 160-channel neuromagnetometer with Piezo-actuator tactile stimulation device. The stimuli were applied to the index or little finger. SEFs by electrical stimulation of median nerve were also recorded.

Result: Tactile stimulation to the index finger evoked dipoles in the post-central gyrus with latencies of 40 ms, directing posteriorly, constantly in all subjects. At 26 ms, dipoles directing anteriorly were also recorded in three subjects. Stimulation to little fingers also evoked the similar dipoles as index fingers with smaller amplitudes in some subjects. Electrical stimulation evoked dipoles with posterior direction at 35 ms in the post-central gyrus.

Discussion: Tactile stimuli to the index finger evoked larger activities than those to the little finger. Tactile stimuli did not evoke a dipole similar with N20m by electrical stimuli. The tactile stimuli may activate Meckel disk and/or Meissner corpuscle, conducting through slow nerve fibers of class two. The dipole by tactile stimuli may correspond to P30m of electrical SEF, but not N20m.

P-D-10

Distributions of activation on somatosensory cortex in time-delay conditions by bilateral median nerve stimulation

Atsushi Fukunaga 1), Takayuki Ohira 1), Masayuki Kamba 2), Maaya Orii 1), Masahito Kobayashi 1), Seiji Ogawa 2), Takeshi Kawase 1)

1) Department of Neurosurgery, Keio University School of Medicine, Tokyo, Japan
2) Hamano Life Science Research Foundation, Tokyo, Japan

Aim: The aim of this study is to investigate how the somatosensory cortex can be activated in three time-delay conditions by bilateral electrical median nerves stimulation (MNS), using fMRI and MEG.

Methods: Activated BOLD signals were observed during MNS by fMRI at a 3.0T magnetic field in 6 normal subjects. The three time-delay conditions were no-delay (simultaneous), 30-ms-delay and 100-ms-delay. SEFs were recorded by 160 channels magnetometers in one normal subject.

Results: In the fMRI study, the secondary somatosensory cortex produced responses by simultaneous MNS in all the subjects. In the 30-ms-delay condition, activated BOLD signals were the smallest of the three conditions. A MEG study revealed that N20m responses were observed in all the conditions, though the amplitudes were not amplified.

Conclusions: Our study suggested that comprehensive approach using fMRI and MEG could be useful to illuminate a neural interaction between the two pathways of bilateral peripheral stimulation processing. However, further investigation should be needed to investigate the role of somatosensory cortex during bilateral MNS.
P-D-11

Natural tactile stimuli for MEG experiments

Veikko Jousmaki 1), Nobuyuki Nishitani 2,3), Riitta Hari 1)

1) Brain Research Unit, Low Temperature Laboratory, Helsinki University of Technology, Espoo, Finland
2) Fujita Neurological Clinic, Osaka, Japan
3) Department of Brain Pathophysiology and Neurology, Kyoto University, Kyoto, Japan

Electric stimuli are widely used in clinical studies to elicit reliable somatosensory evoked fields (SEFs). Such unspecific stimuli suit well for mapping of the primary (SI) and secondary somatosensory (SII) cortices. Natural, selective stimuli for mechanoreceptors are more difficult to apply but could be useful also in clinical functional mapping.

We present MEG-compatible, manually-operated stimulators to produce skin stretch and brush stroke with a precise triggering. The stretch stimulator uses a strain gage transducer for triggering and the brush stimulator uses optoelectronics. Both stimulators elicit clear responses of the contralateral SI cortex, peaking at about 60 ms after a stimulus applied to the hand. The stretch stimulator also elicits, in addition to the contralateral SI responses, bilateral responses of the SII cortices, peaking around 100-150 ms. These natural, ecologically relevant stimuli can be easily applied to any body part and they are well tolerated by all subjects.


P-D-12

Quantitative analysis of somatosensory evoked fields using standardized low-resolution electromagnetic tomography

Yuzo Terakawa 1), Naohiro Tsuyuguchi 1), Yoshihito Shigihara 2), Hideji Hattori 3), Hiroaki Tanaka 4), Kenji Ohata 1)

1) Department of Neurosurgery, Osaka City University Graduate School of Medicine, Osaka, Japan
2) Department of Physiology, Osaka City University Graduate School of Medicine, Osaka, Japan
3) Department of Pediatrics, Osaka City University Graduate School of Medicine, Osaka, Japan
4) MEG Department, Yokogawa Electric Corporation, Osaka, Japan

Objective: Spatial filtering technique is sometimes used to analyze magnetic brain activities that are difficult to detect by single dipole model. However, it remains unclear how accurately the analytical results reflect real brain function. This study was conducted to verify the quantitative analysis of somatosensory evoked fields (SEF) by standardized low-resolution electromagnetic tomography (sLORETA).

Methods: SEFs were obtained from 10 hemispheres of five healthy right-handed volunteers stimulated at 0.75, 1.0, 1.25, 1.5, and 1.75 TMT (threshold of thenar muscle twitch). The N20m of the SEF determined were quantitatively analyzed using a dipole model and sLORETA and compared.

Results: Both dipole moment and sLORETA intensity increased proportionally to stimulus intensity between 0.75 and 1.5 TMT, and tended to reach a plateau at higher stimulus intensities.

Conclusions: sLORETA is as useful in quantitatively evaluating SEF intensity as the single dipole model.
P-D-13

Somatosensory evoked magnetic fields (SEFs) from buccal and tongue mucosa using piezo-driven tactile stimulation device

Yohei Tamura 1), Koutaro Kubo 2), Masuro Shintani 3), Masakazu Tasaki 4), Yoshiyuki Shibukawa 4), Tatsuya Ichinohe 1)

1) Department of Dental Anesthesiology, Tokyo Dental College, Tokyo, Japan
2) Shiratori Dental Implant Center, Shizuoka, Japan
3) Oral Health Science Center, Tokyo Dental College, Tokyo, Japan
4) Department of Physiology, Tokyo Dental College, Tokyo, Japan

Recordings of somatosensory evoked magnetic fields (SEFs) following stimulation of oral structures are considered to be difficult by following reasons: 1) oral mucosa is exposed to moist environment by saliva resulting in the current leak during electrical stimulation, 2) stimulation noise is contaminated into the SEFs because SQUID sensors are in contiguity with oral region, and 3) electric stimulation to the tongue induces electrical taste. To avoid these difficulties due to electrical stimulation, we utilized piezo-driven tactile stimulation device. Using the device, we recorded SEFs following buccal and tongue mucosa tactile stimulation to identify cortical somatosensory representation areas. Tactile stimulation was applied to the each location by piezo-driven tactile stimulation device. Following tactile stimulation, the initial peak latencies of SEF response were found around 27 ms (1M). ECD generated by 1M response of SEF following index finger tactile stimulation was located in the primary somatosensory cortex where is same area activated by 20 ms latency of SEF following median nerve electric stimulation. ECDs generated by SEFs following buccal and tongue mucosa tactile stimulation were located in the primary somatosensory cortex with anterior, lateral, and inferior orientation compared with orientation of index finger representing area.

P-D-14

Somatosensory evoked magnetic fields elicited by sacral surface electrical stimulation

Mabumi Matsushita 1), Nobukazu Nakasato 2), Haruo Nakagawa 1), Akitake Kanno 2) Yasuhiro Kaiho 1), Yoichi Arai 1)

1) Department of Urology, Tohoku University Graduate School of Medicine, Sendai, Japan
2) Department of Neurosurgery and Tohoku Ryogo Center, Kohnan Hospital, Sendai, Japan

Purpose: Somatosensory evoked magnetic fields (SEFs) were measured to explore brain response by sacral surface therapeutic electrical stimulation (SSTES) for the treatment of refractory urinary incontinence and frequent micturition.

Materials and Methods: In six healthy males, a pair of skin surface electrodes was placed symmetrically over the bilateral second through forth posterior sacral foramen. The stimulus intensity was adjusted to just below the pain threshold. SEFs for SSTES were compared with the SEF for the left and right median (MN) and posterior tibial nerves (PTN). Source of all the first peaks were superimposed on individual magnetic resonance imaging.

Results: SEFs for SSTES were observed in all subjects. The first peak latency for SSTES (M30) was 30.2 ± 0.8 (mean ± standard deviation) ms (N = 6), shorter than those of MN (20.1 ± 0.9, N = 12) and longer than those of PTN (39.3 ± 1.4, N = 12) ms. The M30 showed a single dipole pattern in the isofield map over the vertex. The M30 dipole was localized near the medial end of the central sulcus.

Conclusion: These results suggest that sacral M30 is the response from primary somatosensory cortex.
Somatosensory evoked magnetic fields following the tongue stimulation

Hitoshi Maezawa ¹), Kazuya Yoshida ²), Jun Matsubayashi ¹), Kazuhisa Bessho ²), Takashi Nagamine ¹), Hidenao Fukuyama ¹)

¹) Human Brain Research Center, Kyoto University, Kyoto, Japan
²) Department of Oral and Maxillofacial Surgery, Kyoto University, Kyoto, Japan

Somatosensory evoked magnetic fields (SEFs) following the tongue stimulation of either the right or left side were investigated in 10 normal subjects using newly developed device. All the subjects showed at least three out of four components (P25m, P40m, P60m and P80m) over the contralateral hemisphere. The mean ± standard deviation of the peak latencies were 24.3 ± 2.0, 38.1 ± 3.8, 55.6 ± 9.0 and 79.4 ± 7.5 ms following the right side stimulation and 23.8 ± 1.5, 40.4 ± 4.2, 58.3 ± 8.4 and 83.2 ± 9.0 ms after the left side stimulation respectively. We calculated the mean amplitude within 10 to 100 ms for the root-mean-square (RMS) over the contralateral hemisphere (RMS (10-100)), where RMS was calculated from the 18-channel waveform including maximum amplitude channel. RMS (10-100) for the right and left stimulation was 16.8 ± 11.5 and 17.5 ± 11.0 fT/cm respectively. The ratio for RMS (10-100) of right versus left side stimulation was 0.95 ± 0.17. Despite the inter-subject variability of the SEF morphology and amplitude, a high intra-subject correlation was observed between the hemispheres. This inter-hemispheric SEF correlation parameter can provide useful information to detect unilateral abnormalities in the tongue.

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