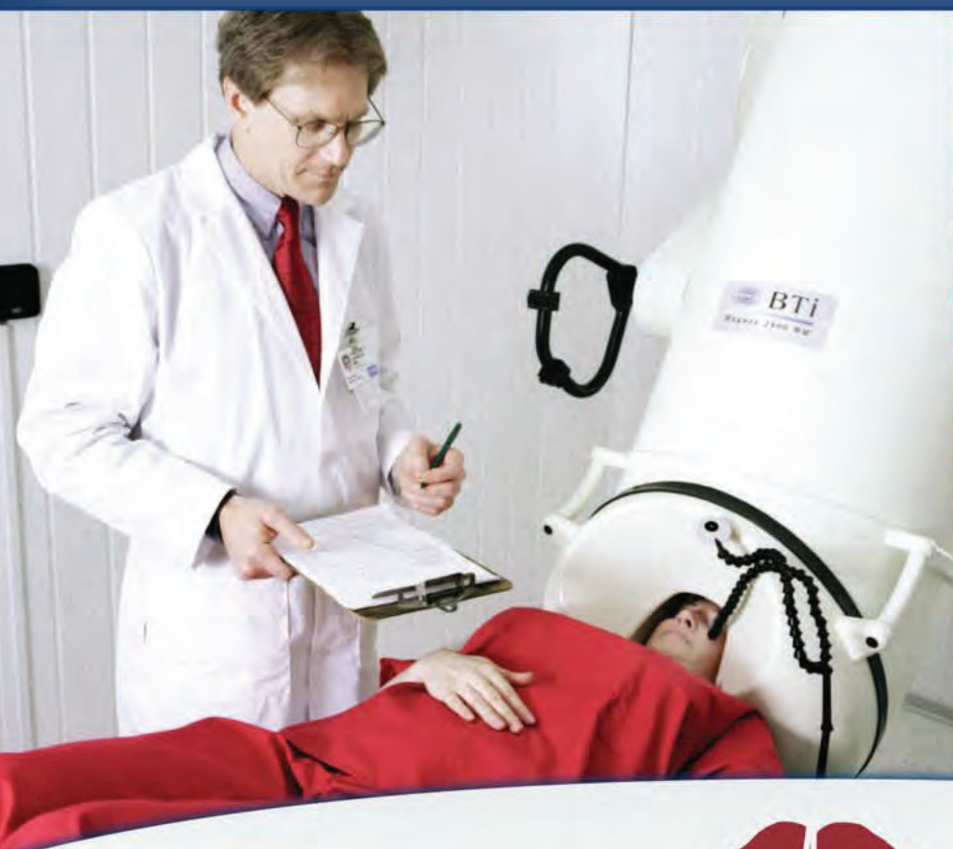
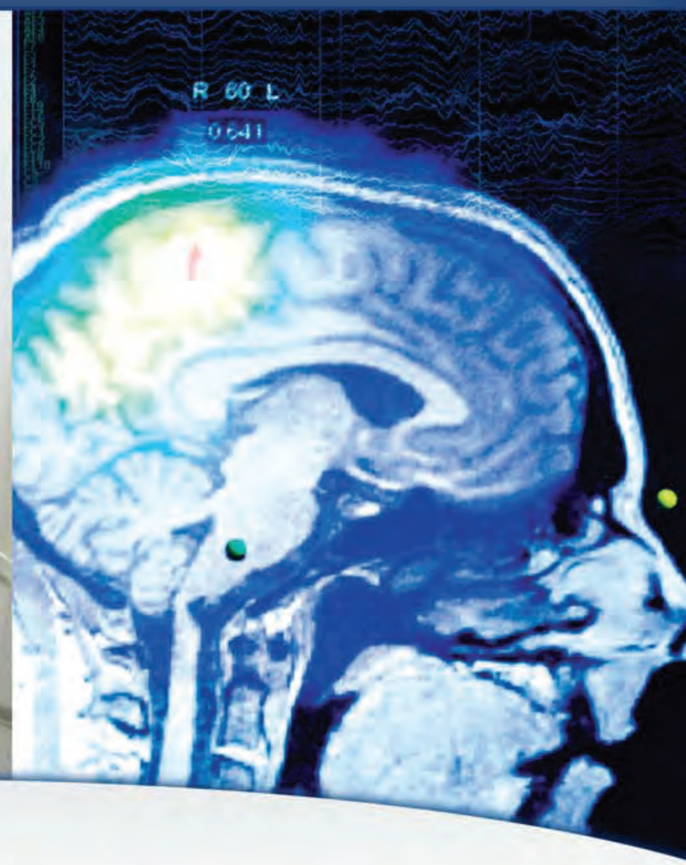
7th Annual ACMEGS Conference | Miami, FL | February 7

ACMEGS CONFERENCE 2013





ACMEGS

AMERICAN CLINICAL MEG SOCIETY

Welcome to Miami!

On behalf of the Program and Course Committees and the ACMEGS Board, I hope that you enjoy your visit to Miami, its climate, food and people.

This is our 7th Annual Conference of the ACMEGS and the fourth joint meeting with the American Clinical Neurophysiology Society (ACNS). The goal of this format is to save ACMEGS members who are also associated with ACNS one trip to a conference, as well as to spark some interest among the members of ACNS who are not so familiar with MEG technology and its clinical applications. After all, MEG is a neurophysiological method, and we have been enjoying a productive synergy with our sister society (ACNS).

As usual, we kept the Annual Business meeting and the MEG-Economics component to the morning session to encourage interested ACNS members to join us subsequently for the scientific presentations.

The past year was another successful year for our Society, during which we resolved all administrative issues with the Commonwealth of Massachusetts, reached out to other related professional organizations (i.e. ACNS, AES, ASET, ABRET, etc.), increased our Center membership and continued to work on enhancing the value of the Society to its members and the value of the MEG Centers to their institutions. To this extent, we also engaged in a conversation with the Research Triangle Institute that performs annual US News & World Report Hospital rankings.

We will have a very interesting scientific program this year with eight presentations delivered by experts in the field of clinical MEG, and we are very glad to welcome among them Dr. Ritva Paetau from Finland, and Dr. Sylvain Baillet from Canada.

Our conference aims to provide an informal and friendly atmosphere for discussing and exchanging recent clinically relevant studies that might lead to new clinical MEG indications. In addition we are dedicated to enabling you, our members, to promote the appropriate use of Magnetoencephalography. We wish to empower you to work closely with national and local health insurance carriers and governmental regulatory bodies to ensure accurate and successful reimbursement.

Welcome to Miami and I hope you will enjoy the conference and our traditional Society dinner at the end of a day filled with lectures and discussions.

Sincerely,
Anto Bagić, M.D., Ph.D.
President, American Clinical Magnetoencephalography Society

Organizing Committee:
Anto Bagić, University of Pittsburg, Pittsburgh PA
Susan Bowyer, Henry Ford Hospital, Detroit MI
Richard Burgess, Cleveland Clinics Foundation, Cleveland OH
Michael Funke, University of Texas, Houston, TX
Jeffrey Lewine, MIND Research Network, Albuquerque NM
John Ebersole, University of Chicago, Chicago, IL
Gretchen Von Allmen, University of Texas, Houston, TX

ACMEGS Annual Meeting Program

February 7, 2013 ♦ Miami Marriott Biscayne Bay ♦ Miami, Florida

8:00 AM **Arrival/Breakfast Reception**

8:45 AM **Welcome and Introduction**
ACMEGS Presidential Address - Anto Bagic, M.D.

9:00 AM **Business Meeting (ACMEGS Members Only)**
* Financial Report - Susan Bowyer, M.D.
* Public Relations Committee - Susan Bowyer, M.D.
* New Business/Elections
* Update on Reimbursement/Coverage - Mr. Michael Longacre

10:00 AM **Workshop: Ictal MEG - Chairperson: Anto Bagic, M.D.**
* Ictal MEG: High Hopes and Mixed Fulfillments - Anto Bagic, M.D.
* Methodological and Clinical Aspects of Ictal MEG - Ritva Paetau, M.D.
* Ictal Events Simultaneously Modeled By MEG and EEG - John Ebersole, M.D.
* Sensitivity and Specificity of Seizure-Onset Zone Estimation by Ictal Magnetoencephalography - Ritva Paetau, M.D.

12:00 PM **Annual ACMEGS Photo Shoot/Lunch**

1:30 PM **Poster Session**

2:00 PM **Workshop: Clinical MEG - Chair: Michael Funke, M.D.**
* Technical Expert's View: Source Models in Clinical MEG: A Review - Sylvain Baillet, Ph.D.
* Clinician's View: Role of MSI in Pediatric Epilepsy - Gretchen Von Allmen, M.D.
* Clinical Researcher's View: Genuine Benefits of MEG in Epilepsy - Robert Knowlton, M.D.

3:30 PM **Coffee Break**

4:00 PM **Update on Educational Initiatives - Chair: Anto Bagic, M.D.**
* Update on Clinical MEG Fellowship - Richard Burgess, M.D.
* Update on MEG/EEG-Technologist Survey - Judy Ahn-Ewing, R EEG/EP T, CNIM
- Janice Walbert, R EEG T
* Discussion

4:30 PM **ACMEGS Annual Lecture: Simultaneous MEG and Intracranial EEG Recordings: What Have We Learned?** - Andreas Alexopoulos, M.D.

5:30 PM **Meeting Adjourn**

6:00 pm **ACMEGS Dinner** CASABLANCA
(Casablanca on the Bay ♦ 1717 North Bayshore Drive ♦ Just minutes from the Miami Marriott Biscayne Bay ♦ Please refer to the walking map at the end of the handout)

ACMEGS Presidential Address

Anto Bagic, M.D., Ph.D.
Department of Neurology, University of Pittsburgh Medical Center, Pittsburg, PA

Anto Bagic

Presidential Address 2013

Anto Bagić, MD, PhD
(Pittsburgh, PA)

February 7, 2013; Miami, FL

ACMEGS Year In Retrospect (1/5)

- Society in good standing with Commonwealth of MA.
- Center Members (16): (32 delegated members).
- Individual Members: 21.
- First full year with S&S.

Society In Good Standing With The Commonwealth Of MA

- Administrative Issues
  - All resolved
  - Collective efforts:
    - ACMEGS Board
    - S&S Management Inc.
    - Attorney in Boston
    - Accountant in Pittsburg

2012 ACMEGS Honor Roll

1	Alexian Brothers Neuroscience Institute	Elk Grove Village	IL
2	Atlantic Neuroscience Institute	Summit	NJ
3	Children's Hospital of Philadelphia	Philadelphia	PA
4	Cincinnati Children's Hospital	Cincinnati	OH
5	Cleveland Clinic Foundation	Cleveland	OH
6	Cook Children's Healthcare System	Fort Worth	TX
7	Froedtert Hospital	Milwaukee	WI
8	Henry Ford Hospital	Detroit	MI
9	Meadowlands Hospital	Secaucus	NJ
10	MIND-University of New Mexico	Albuquerque	NM
11	Minnesota Epilepsy Group	St. Paul	MN
12	Nebraska Medical Center	Omaha	NE
13	University of California San Francisco	San Francisco	CA
14	University of Pittsburgh Medical Center	Pittsburgh	PA
15	University of Tennessee	Memphis	TN
16	UT Epilepsy MEG Program	Houston	TX

(32 delegated members)

Individual ACMEGS Members

Our First Full Year With S&S

S & S MANAGEMENT SERVICES, INC.

About S & S Management | What We Do | Examples Of Excellence | About Our Staff
About Our Office | Our Officers | Our Clients | Testimonials | Contact S & S

About S & S Management Services:

S & S Management Services, Inc., was Accredited by ASAE's AMC Accreditation program for the period December 20, 2001, until dissolution of the Accreditation program, effective December 31, 2010.

Based in Bloomfield, Connecticut, just five minutes from downtown Hartford and fifteen minutes from Bradley International Airport, S & S Management Services is a firm specializing in association management, public relations, and government relations for business and professional associations.

S & S represents medical, professional, commercial, and trade associations. It is one of the largest association management firms in New England. The firm is headed by Arthur N. Schuman, Mark R. Schuman and C. Mitchell Sorensen, who have accumulated over 60 years of experience as association executives. The staff at S & S recognizes the importance of human relations in implementing any association management program, and we require that our personnel be innovators, researching problems and seeking solutions for the consideration and approval of an association's governing body.

Press Release

Press Release

Press Release

Ms. Jacquelyn T. Coleman, CAE
Senior Vice President

Ms. Marie Westlake

Ms. Haley Burns

ACMEGS Year In Retrospect (2/5)

- Meeting with Elekta leadership (AES, December 2, 2012).
- AES Epilepsy Resource Center (December 3, 2012).
- Continued productive relationship with the ACNS.
- Planning for the 2nd Board Retreat (likely Pittsburgh, PA; May 12-14, 2013).

AES Meeting with ELEKTA Leadership

Elekta Delegation

- **Tom Brennan** *National Sales Manager, Neuro*
- **Jonas Karlström** *VP Service & Operations*
- **Antti Ahonen** *VP Research and Customer Relations*
- **Miikka Putaala** *Director, Business Line MEG*
- **Gordon Haid** *Director of NA MEG Sales (Western US and Canada)*
- **Jim Petite** *Director of NA MEG Sales (Eastern US and Mexico)*

ACMEGS Delegation

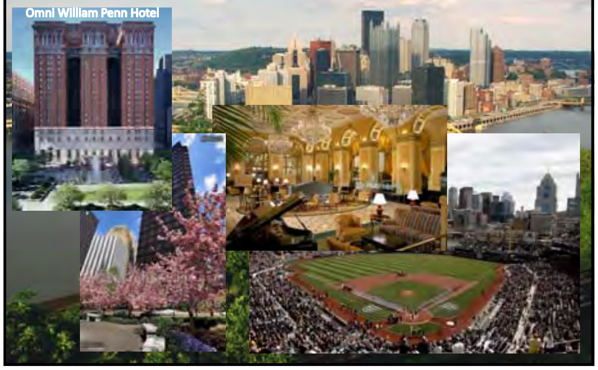
- Anto Bagić, MD, PhD
- Rick Burgess, MD, PhD
- John Ebersole, MD
- Michael Funke, MD, PhD
- Jeffery Lewine, PhD
- Gretchen Von Allmen, MD

December 2, 2012; San Diego, CA

Continued Productive Relationship with the ACNS

ACMEGS

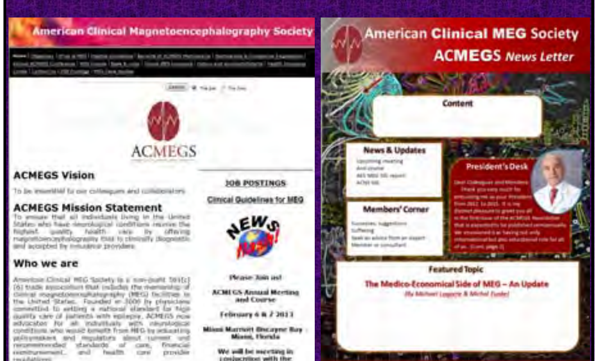
Planning for the 2nd Board Retreat (likely Pittsburgh, PA; May 12-14, 2013).

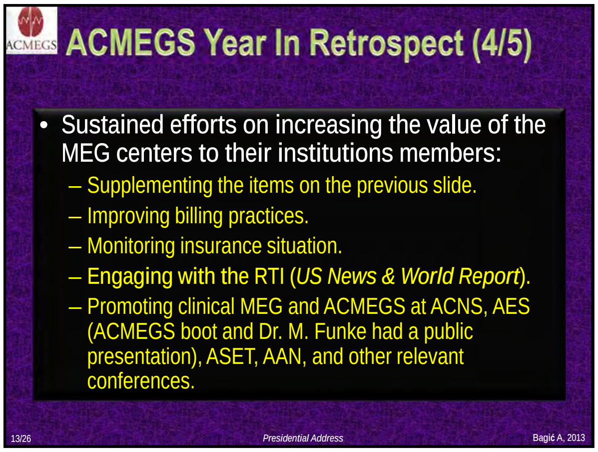


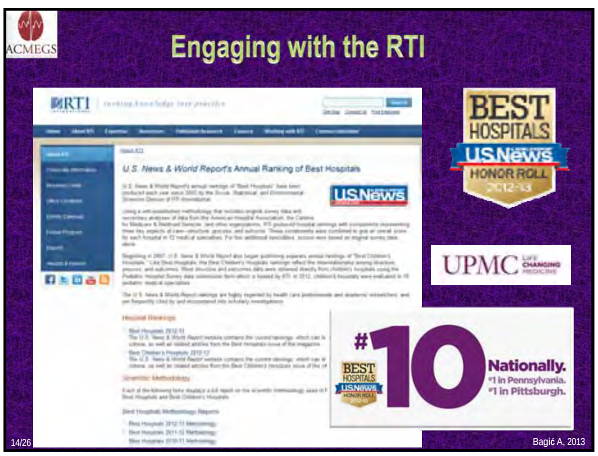
ACMEGS Year In Retrospect (3/5)

- Continued efforts on increasing the value to our (center) members:
  - Web-based resources (policies, CPGs, cases, jobs, etc.).
  - Addressing individual center member concerns.
  - Assistance to the new sites.
  - Strategic decision not to get on the CMS radar.
  - Newsletter (Check it out and contribute!).
  - Website redesign (upcoming).

ACMEGS Web-based Resources




ACMEGS
ACMEGS Year In Retrospect (4/5)
• Sustained efforts on increasing the value of the MEG centers to their institutions members:
– Supplementing the items on the previous slide.
– Improving billing practices.
– Monitoring insurance situation.
– Engaging with the RTI (US News & World Report).
– Promoting clinical MEG and ACMEGS at ACNS, AES (ACMEGS boot and Dr. M. Funke had a public presentation), ASET, AAN, and other relevant conferences.
13/26
Presidential Address
Bagić A, 2013


ACMEGS
Engaging with the RTI
RTI
U.S. News & World Report's Annual Ranking of Best Hospitals
US News
BEST HOSPITALS
US News
HONOR ROLL
2012-13
UPMC
#10
Nationally.
#1 in Pennsylvania.
#1 in Pittsburgh.
14/26
Bagić A, 2013


18th International conference on Biomagnetism
August 26-30, 2012
BIOMAG 2012 Paris

ACMEGS Year In Retrospect (5/5)

- ACMEGS educational efforts and activities:
  - Annual Course.
  - Survey on the training opportunities (Dr. R. Burgess).
  - Upcoming discussion later today (Moderator: Dr. R. Burgess).
  - Fellowship concept.
  - MEG technologists survey (ASET).
  - Web-based resources.
  - Individual help.

17/26 Presidential Address Bagić A, 2013

The 1st Annual MEG Course

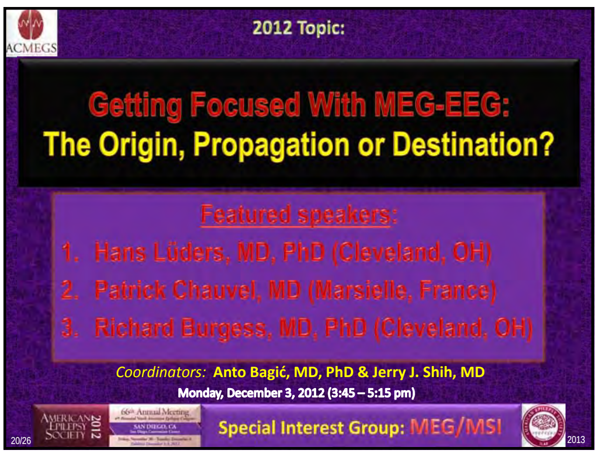
Clinical MEG Course (7h CME credit)

Principles and practice of Clinical Magnetoencephalography

7:30 AM	Registration / Breakfast	
8:00 AM	Welcome / Introduction	John Ebersole, M.D.
8:15 AM	Neurophysiological Basis and Recording Fundamentals of MEG and EEG	Richard Burgess, M.D., Ph.D.
9:05 AM	MEG Lab Organization and Data Acquisition	Anto Bagic, M.D., Ph.D.
9:55 AM	Break	
10:10 AM	Dipole Monitoring of Epileptiform Activity	John Ebersole, M.D.
11:00 AM	Source Modeling of Evoked Activity	Michael Funke, M.D., Ph.D.
11:50 AM	Questions / Discussions	Faculty
12:15 PM	Lunch	
1:15 PM	Interactive Workshop: Analysis of Cases with Epileptiform Activity	John Ebersole, M.D. Susan Ebersole, R.EEG.T.
2:45 PM	Break	
3:00 PM	Interactive Workshop: Analysis of Cases with Evoked Eloquent Cortex Responses	Susan Bowyer, Ph.D.
4:30 PM	Closing Remarks / Farewell	John Ebersole, M.D.

18/26 Presidential Address Bagić A, 2013

TRAILBLAZING
NEUROPATHWAYS
N
W
E
S
ASET 2012 ANNUAL CONFERENCE
AUGUST 2 - 4, 2012
CROWNE PLAZA ST. PAUL RIVERFRONT
SAINT PAUL, MN
A MEG workshop
was offered to the EEG
technologists for the first time
ASET



ACMEGS
2012 Topic:
Getting Focused With MEG-EEG:
The Origin, Propagation or Destination?
Featured speakers:
1. Hans Lüders, MD, PhD (Cleveland, OH)
2. Patrick Chauvel, MD (Marsielle, France)
3. Richard Burgess, MD, PhD (Cleveland, OH)
Coordinators: Anto Bagić, MD, PhD & Jerry J. Shih, MD
Monday, December 3, 2012 (3:45 – 5:15 pm)
20/26
AMERICAN EPILEPSY SOCIETY
2012
66th Annual Meeting
SAN DIEGO, CA
Special Interest Group: MEG/MSI
2013

AES 2012
MEG/MSI SIG
> 200 attendees
Monday, December 3, 2012; 3:45 – 5:15 pm (San Diego, CA)

What Is Ahead?

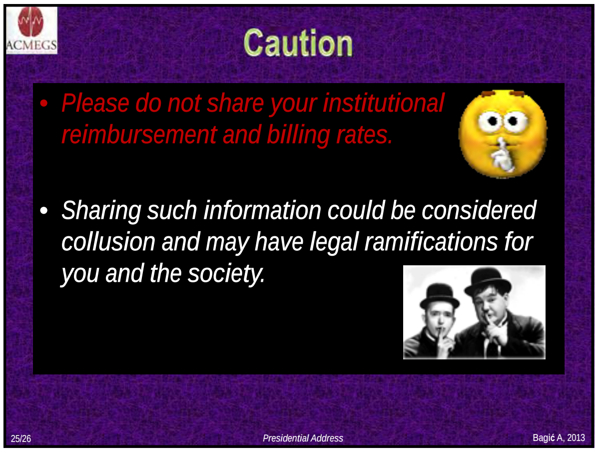
- Sustain the current efforts on all fronts.
- Cultivate the relationship with the ACNS.
- Structure relationship with Elekta.
- Increase our presence at appropriate neurosurgical conferences.
- Escalate efforts on increasing (center) membership.
- Foster the relationship with the AES, AAN, ASET, ABRET, ISACM.
- Facilitate collaborative efforts on clinical research leading to new potential indications for MEG.

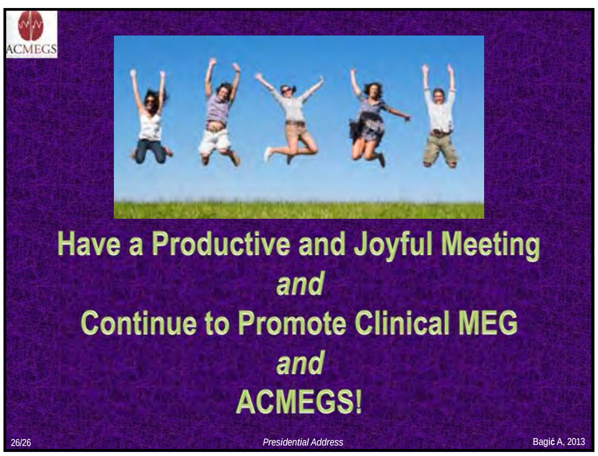
Tune Your Travel Plans

- ACNS 2013 Annual Meeting (February 8 - 10, 2014). You are here!
- ISACM 2013 (Sapporo, Japan, August 28 - 30, 2013).
- AES 2013 Annual Meeting (Washington, DC; December 6 - 10, 2013).
- ACMEGS 2014 Annual Meeting (Atlanta, GA; February 6, 2014).
- ACNS 2014 Annual Meeting (Atlanta, GA; February 7 - 9, 2014).
- Biomag 2014 (August 24 - 29, 2014; Halifax, Canada)

Acknowledgments

- ACMEGS Members (Centers and individuals)
- Elekta Neuromag Oy
  - Unrestricted educational grant
- ACNS
  - Synchronized meetings
  - CME approval
  - Sharing posters
- ASET/ABRET
  - Educational programs for technologists
- S&S Management Inc. (Jackie Coleman, Marie Westlake)


ACMEGS
Caution
Please do not share your institutional reimbursement and billing rates.
Sharing such information could be considered collusion and may have legal ramifications for you and the society.
25/26
Presidential Address
Bagić A, 2013


ACMEGS
Have a Productive and Joyful Meeting
and
Continue to Promote Clinical MEG
and
ACMEGS!
26/26
Presidential Address
Bagić A, 2013

ACMEGS Annual Business Meeting

I. Call to Order (Dr. Bagic)

II. Minutes of February 9, 2012, Business Meeting (Dr. Bagic)

III. President's Report (Dr. Bagic)

IV. Financial Report (Dr. Bowyer)

V. Public Relations Report (Dr. Bowyer)

VI. New Business/Elections (Dr. Bagic)

VII. Update on Reimbursement/Coverage (Mr. Longacre)

VIII. Adjourn

ACMEGS President's Report

Anto Bagic, M.D., Ph.D.
Department of Neurology, University of Pittsburgh Medical Center, Pittsburg, PA

Anto Bagic

Notes

ACMEGS Financial Report

Susan Bowyer, Ph.D.
Henry Ford Health System, Detroit, MI

Susan Bowyer

Notes

ACMEGS Public Relations Report

Susan Bowyer, Ph.D.
Henry Ford Health System, Detroit, MI

Susan Bowyer

Notes

New Business/Elections

Anto Bagic, M.D., Ph.D.
Department of Neurology, University of Pittsburgh Medical Center, Pittsburg, PA

Anto Bagic

Notes

2013 ACMEGS Initiative
Affordable Care Act - Medicaid Strategy
Michael Longacre
Executive Director, ACMEGS

Michael Longacre

7th Annual Society Meeting
Miami
February 6-7, 2013

Michael Longacre
Executive Director

2013
ACMEGS Initiative
Affordable Care Act - Medicaid Strategy

Medicaid

- Medicaid is the United States health benefit program for people with low incomes and limited financial resources.
- Medicaid is essentially an entitlement program
  - where the costs are shared by the states and the federal government,
  - and the local Medicaid programs are managed by the states.
- It is financed through a state-federal partnership, with Washington paying an average of 57 cents of every dollar spent.

Medicaid

- Medicaid provides comprehensive and long-term medical care for more than 60 million low-income Americans.
- Medicaid spending for 2009 was $380.6 billion and in 2010 was estimated at $404.9 billion.
- In 2011, it was estimated that 1 in 5 Americans were enrolled in the Medicaid program.

ACA - Medicaid

- Under the Affordable Care Act (ACA), Medicaid is one of the platforms to expand health care coverage. Roughly half of the people newly "covered" through the ACA are projected to be enrolled in Medicaid.
- The ACA hopes to expand Medicaid beyond its current population and potentially cover all adults making up to 138 percent of the federal poverty level. In return, states that expand their programs would receive an increase in their federal reimbursement.

ACA - Medicaid

- The ACA compelled states to cover this expanding population or risk losing all of their federal Medicaid reimbursement. But the Supreme Court held this provision unconstitutional. Whether to expand coverage under Medicaid is now a state's choice.
- A major source of savings for several of the states will be the ACA's higher federal match (100% for 2014–16 and then gradually declining to 90 percent in 2019 and beyond)7 for populations under 139 percent of FPL that they already provide limited Medicaid coverage to or currently cover in state-only financed health programs.

Requirements for the Exchanges

- The states must establish an Insurance Exchange by 2014 or allow the federal government to establish one for the states
- The states must demonstrate significant progress in the establishment of the Exchange and signal "readiness" in 2013
  - Expected to be ready for open enrollment by October 1, 2013

State Federal Partnership Exchange

To date, six states are planning to pursue a state-federal partnership exchange: Arkansas, Delaware, Illinois, Michigan, North Carolina, and Ohio. However, Governors in Michigan and Arkansas have indicated their preference for a state-based exchange and continue to work with their legislatures to press for the passage of authorizing legislation. Similarly, Illinois has already signaled that it will move to a state-based exchange in 2015. While only a few states have committed to a partnership to date, this option may become an increasingly viable strategy for the 10 states that remain undecided. States not ready to run their own exchanges in 2014 may transition from a partnership exchange to a fully state-based exchange at a later date when they have the capability, though they must receive approval for their exchange at least 11 months prior to the start of coverage.

Federally Facilitated Exchanges

- As of the end of November 2012, 17 states had declared they would not create a state-based exchange and will likely to a federally-facilitated exchange. Many of these states had decided early on to default to a federal exchange; however, some had begun laying the foundation for a state-based or partnership exchange before reversing course.

State-Based Exchanges

State	Structure of Exchange	Governance	Contracting Relationship with Plans
California	Quasi-governmental	5-member Board	Active purchaser
Colorado	Quasi-governmental	12-member Board	Clearinghouse
Connecticut	Quasi-governmental	14-member Board	Active purchaser
District of Columbia	Quasi-governmental	11-member Board	Active purchaser
Hawaii	Non-profit	15-member Board	Clearinghouse
Iowa	Not yet addressed	Not yet addressed	Not yet addressed
Kentucky	Operated by State	11-member Board	Not yet addressed
Maryland	Quasi-governmental	9-member Board	Clearinghouse (until 2016)
Massachusetts	Quasi-governmental	11-member Board	Active purchaser
Minnesota	Not yet addressed	Not yet addressed	Not yet addressed
Mississippi	Non-profit	9-member Board	Not yet addressed
Nevada	Quasi-governmental	10-member Board	Clearinghouse
New Mexico	Quasi-governmental	10-member Board	Not yet addressed
New York	Operated by State	5 Regional Advisory Committees	Not yet addressed
Oregon	Quasi-governmental	9-member Board	Active purchaser
Rhode Island	Operated by State	13-member Board	Active purchaser
Vermont	Operated by State	5-member Board	Active purchaser
Washington	Quasi-governmental	11-member Board	Clearinghouse

ACA - Medicaid

- Political Consideration: Federally managed state insurance exchanges are expected to aggressively sign up eligible Medicaid beneficiaries

- It is estimated that by 2020,1 in 4 Americans could be eligible for Medicaid

State Medicaid Programs

State	State Medicaid Program Names
Alabama	Alabama Medicaid
Alaska	Alaska Medicaid
Arizona	Arizona Health Care Cost Containment System (AHCCCS)
Arkansas	Arkansas Medicaid
California	Medi-Cal
Colorado	Colorado PEAK
Connecticut	Connecticut Medicaid
Delaware	Deleware Medicaid
District of Columbia	DC Medicaid
Florida	Florida Medicaid
Georgia	Georgia Medicaid
Hawaii	QUEST
Idaho	Idaho Medicaid
Illinois	Family Care
Indiana	Hoosier Healthwise
Iowa	Iowa Medicaid Enterprise
Kansas	Kansas Medicaid and HealthWave
Louisiana	Louisiana Medicaid
Maine	MaineCare Services
Maryland	Maryland Medical Assistance
Minnesota	Minnesota Medicaid

State Medicaid Programs

State	State Medicaid Program Names
Mississippi	Mississippi
Missouri	Missouri HealthNet
Montana	Montana Mecicaid
Nebraska	Nebraska Medicaid
Nevada	Medical Assistance
New Hampshire	New Hampshire Medicaid
New Jersey	New Jersey Medicaid
New Mexico	New Mexico Medicaid
New York	New York Medicaid
North Carolina	North Carolina Medicaid
North Dakota	North Dakota Medicaid
Ohio	Ohio Medicaid
Oklahoma	SoonerCare
Oregon	Oregon Health Plan
Pennsylvania	Medical Assistance
Rhode Island	Rhode Island Medicaid
South Carolina	South Carolina Medicaid
South Dakota	South Dakota Medicaid
Tennessee	TennCare
Texas	Texas Medicaid
Utah	Utah Medicaid

State Medicaid Programs

State	State Medicaid Program Names
Vermont	Green Mountain Care
Virginia	Virginia Medicaid
Washington	Medicaid State Plan
Wisconsin	ForwardHealth
Wyoming	EqualityCare
Vermont	Green Mountain Care

Medicaid Strategy

1. Prepare a packet of materials to support the clinical necessity of MEG in children with epilepsy.

2. Each MEG center should contact your state Medicaid agency and make inquires concerning coverage and reimbursement for MEG.
   1. A listing of all state Medicaid agencies can be found on the ACMEGS web site or available from me via email – longacre777@msn.com

Medicaid Strategy

Discussion

Who has interacted with their state Medicaid agency?

What information was required?

What was the result?

What additional resources might be available to influence your state Medicaid agency?

ACMEGS
AMERICAN CLINICAL MEG SOCIETY

Thank you!

ACA - Medicaid

1. By 2014, Medicaid coverage will be expanded to everyone under the age of 65 that are below 133% of the Federal Poverty Level (FPL), also known as the poverty guidelines. This will remove the current Medicaid eligibility criteria which leaves many individuals that are currently in poverty to go uninsured.
2. Increase Medicaid reimbursements to 100% of Medicare for primary care providers for 2013 and 2014.
3. Under the Medicaid drug rebate program equalize treatment of fee-for-service and managed care.
4. Create state-based health exchanges where individuals can purchase coverage, with premium and cost-sharing credits are available to individuals and families with incomes between 133% and 400% of the poverty guideline.
5. Provide an individual mandate to make sure that all Americans participate in the insurance risk pool which should result in lower insurance cost coverage for everyone. This also requires that insurers provide coverage to those with pre-exisiting conditions, removes lifetime limits, prevention services must be covered at 100%, and prohibits removing someone from coverage.
6. The Medicare Advantage Special Needs program was reauthorized.
7. By 2020, the Medicare prescription drug "doughnut hole" will be closed.
8. Improve the coordination of Medicaid and Medicare dual eligibles.

3rd ACMEGS Poster Presentation

Complementary Nature of MEG/EEG & SISCOM in Epilepsy Surgery

Michael A. Stein, MD, Travis R. Stoub, PhD, Marvin A. Rossi, MD, PhD

MEG/EEG source localization and SISCOM are functional neuroimaging modalities that can provide localizing information in planning epilepsy surgery when the standard evaluation including MRI, continuous video-EEG monitoring, and neurocognitive evaluation is non-diagnostic. Although others have compared their relative sensitivities (Knowlton RC et al., 2008, Seo JH et al., 2011), this study presents a case series (n=35) analyzing coregistered MEG/EEG and SISCOM data with emphasis on their complementary nature. Since MEG/EEG and SISCOM provide similar but also unique information, we argue that using both in conjunction adds localizing power in planning for epilepsy surgery which should lead to improved outcomes. Both tests have high spatial resolution. Advantages of SISCOM are that it is an ictal measure, and it can localize deep sources. MEG/EEG has advantages of being a direct measure of neuronal function, and having high temporal resolution. When used together MEG/EEG-SISCOM provides information on both ictal and interictal localization with high spatial and temporal resolution. We also show how the shortcomings of one modality can be compensated for with information from the other. Finally a model incorporating MEG/EEG-SISCOM into planning for intracranial electrode placement that minimizes the extent of necessary electrode coverage and hence associated morbidity and mortality is presented.

Focal High Frequency Oscillations With Generalized Seizures

Jeffrey R Tenney, MD, PhD, Hisako Fujiwara, EEGT, Douglas F Rose, MD, Nat Hemasilpin, MS

Background: Absence seizures are characterized by briefly impaired consciousness with diffuse 3 Hz spike and wave discharges on EEG. High frequency oscillations (HFOs) are promising biomarkers of the seizure onset zone. This goal of this study was to use MEG to evaluate whether HFOs occur during childhood absence seizures and where the sources localize.

Methods: Children, aged 6 to 12 years old, with newly diagnosed and untreated absence seizures were recruited and MEG recordings were conducted on a 275 channel CTF magnetometer. Time-frequency analysis using short time fast Fourier transform (STFFT) was completed during absence seizures at 1-20Hz, 20-70Hz, 70-150Hz, and 150-300Hz. Source localization was then completed using a sLORETA algorithm for the first generalized spike and slow wave complex.

Results: Twelve children were recruited and forty-four absence seizures occurred during MEG recording. Time-frequency analysis with STFFT showed significant power density in the 1-20Hz, 20-70Hz, and 70-150Hz bandwidths. Source localized preferentially in the parietal region at 1-20Hz and to the lateral inferior frontal region at 20-70Hz and 70-150Hz.

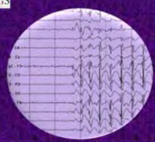
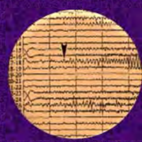
Conclusions: Using MEG, we have been able to detect focal ictal HFOs in children with untreated absence seizures. These areas could be components of the network responsible for generating absence seizures.

Workshop: Ictal MEG

Ictal MEG: High Hopes and Mixed Fulfillments

Anto Bagic, M.D., Ph.D.
Department of Neurology, University of Pittsburgh Medical Center, Pittsburg, PA

Anto Bagic


Ictal MEG: High Hopes and Mixed Fulfillments

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Chief Scientific Advisor, MEG Research
Director, UPMC MEG Epilepsy Program
Associate Professor, Neurology & Neurosurgery
Director, University of Pittsburgh Comprehensive Epilepsy Center (UPCEC)

February 7, 2013

http://www.presentermedia.com/files/animsp/00002000/2483/carrying_question_pa_md_wm.gif

Reality of Medically-refractory Epilepsy*

- About 30% of patients will remain uncontrolled in spite of our best efforts.
- Level I evidence (RTC) for efficacy of surgery exists.
- CPG are defined, endorsed by major societies and widely publicized.
- Medications and surgery are 4 times more likely to control seizures then medications alone.
- A delay from diagnosis to surgery remains about 17 years.
- Surgery is ultimately offered to (at most) 1 in 30 of the potential benefactors.
- **How do we change this tragic reality?**

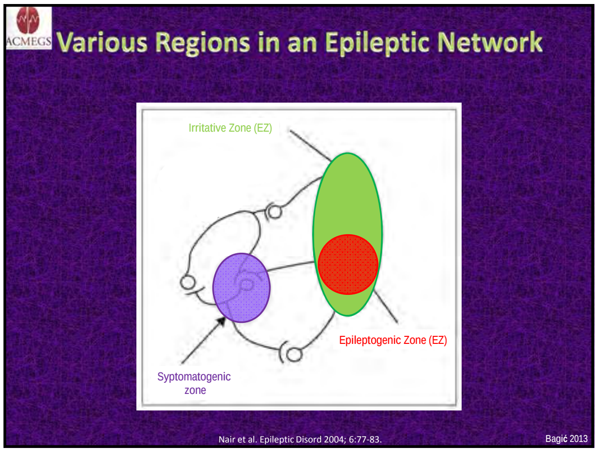
*Kwan & Brodie, NEJM 2000; 342:314-319. Wiebe et al. N Engl J Med 2001;345:311-8. Engel et al. Neurology 2003;60:538–547. Wiebe S. Neurology 2010;75;678-679.

Goals of Presurgical Evaluation

Descriptions of zones and lesions of the cortex (adapted from Lüders and Awad, 1992)*

- **Epileptogenic zone (EZ)**
  - Region of cortex that can generate epileptic seizures.
  - By definition, total removal or disconnection of the epileptogenic zone is necessary and sufficient for seizure-freedom
- **Irritative zone (IZ)**
  - Region of cortex that generates interictal epileptiform discharges in the EEG or MEG
- **Seizure (ictal) onset zone (SOZ)**
  - Region where the clinical seizures originate
- **Epileptogenic lesion**
  - Structural lesion that is causally related to the epilepsy
- **Ictal symptomatogenic zone (ISZ)**
  - Region of cortex that generates the initial seizure symptoms
- **Functional deficit zone (FDZ)**
  - Region of cortex that in the interictal period is functionally abnormal, as indicated by neurological examination, neuropsychological testing and functional imaging or non-epileptiform EEG or MEG abnormalities
- **Eloquent cortex**
  - Region of cortex that is indispensable for defined cortical functions

*Rosenow & Luders, 2001.


ACMEGS
Various Regions in an Epileptic Network
Irritative Zone (EZ)
Epileptogenic Zone (EZ)
Syptomatogenic
zone
Nair et al. Epileptic Disord 2004; 6:77-83.
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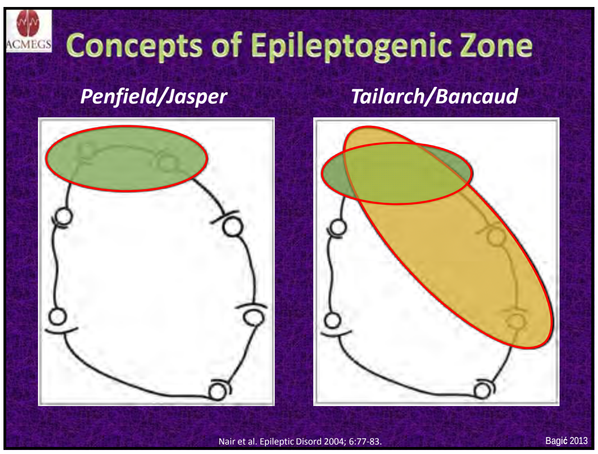
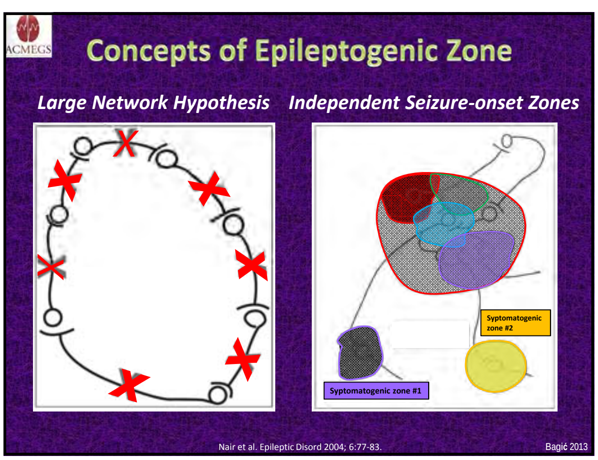

ACMEGS
Concepts of Epileptogenic Zone
Penfield/Jasper
Tailarch/Bancaud
Nair et al. Epileptic Disord 2004; 6:77-83.
Bagić 2013


ACMEGS
Concepts of Epileptogenic Zone
Large Network Hypothesis
Independent Seizure-onset Zones
Syptomatogenic
zone #2
Syptomatogenic zone #1
Nair et al. Epileptic Disord 2004; 6:77-83.
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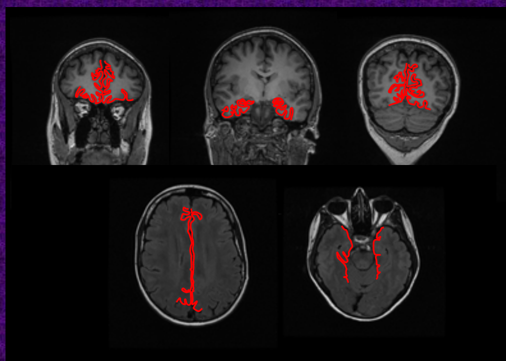
Topology of the Sources



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From Beliefs to Facts

- Believed to be an infrequent spontaneous occurrence.
- First published ECoG-confirmed case in 1992 (Stefan et al.).
- First larger studies with partial-head systems in 2002:
  - Tilz et al (N = 13)
  - Elaishiv et al (N = 7).
- First larger studies with whole-head systems in 2012:
  - Fujiwara et al (N = 8).
  - Medvedovsky et al (N = 12).
- So, how frequntly we capture clinical seiuzre during a MEG?

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Frequency of Ictal MEG Recordings?

- Pittsburgh PA): about 1 in 25.
- Salt Laker City (UT): about 1 in 20.
- Cleveland (OH): 10.3% (Burgess et al, 2013; submitted).
- Helsinki: 47/246 = 19.1% (Medvedovsky et al. 2012).
- Other centers?

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Optimal Strategy?

- Since it is a rare event, do we simply apply watchful waiting?
- Or, do we provoke (facilitate) it?
- If so, how? After all, we don't even have any consistency in approaching activation of IIEDs during MEG recordings…
- Should it be a goal for some or all recordings?
- If we neglect risks, is it worth of effort?

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Extended Recordings*

- The acquisition time: up to 40 h.
- 42.6% experienced a seizure during the first hour.
- 70.7% experienced a seizure within the first 5 hours.

*Medvedovsky et al. 2012.

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Duration of Recordings* (N = 54, Age range: 3 - 40)

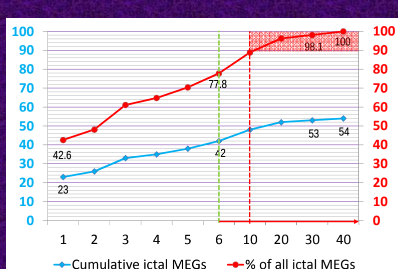

Table S1. MEG acquisition length until the first seizure.

*Medvedovsky et al. 2012.

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What Are Our (Realistic) Options?

- 1. Standard activation procedures.
- 2. Sleep deprivation.
- 3. Pharmacologic manipulations.
- 4. Extended recordings.
- 5. ???

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Methodological Challenges of Ictal MEG

- 1. The limited time of MEG recording.
- 2. The head movements.
- 3. Movement-related magnetic artifacts.
- 4. A low signal-to-noise ratio (SNR) of ictal MEG and EEG signals.
- 5. Topology of the sources.
- 6. Population-specific challenges.

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Population-specific Challenges: Children*

- 1. Extratemporal epilepsy more common.
- 2. Interictal EEG findings are often multifocal or generalized [i.e. malformations of cortical development (MCD)].
- 3. Epileptic spasms may be associated with multifocal or generalized localization on scalp EEG.
- 4. The high prevalence of cases of ''non-lesional'' and ''multilesional'' (i.e. TSC).

*Fujiwara et al. Epilepsy Res. 2012 May;99(3):214-24.

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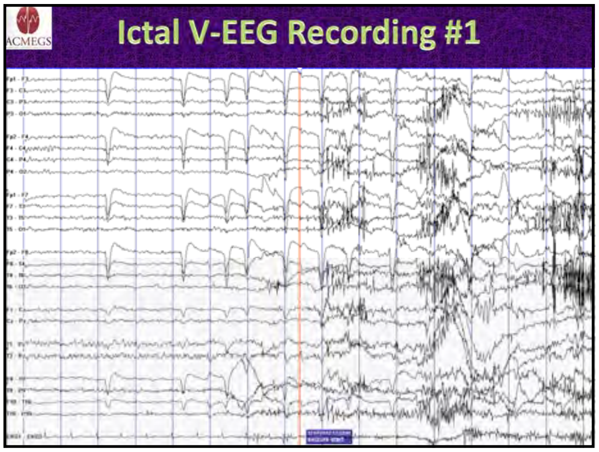
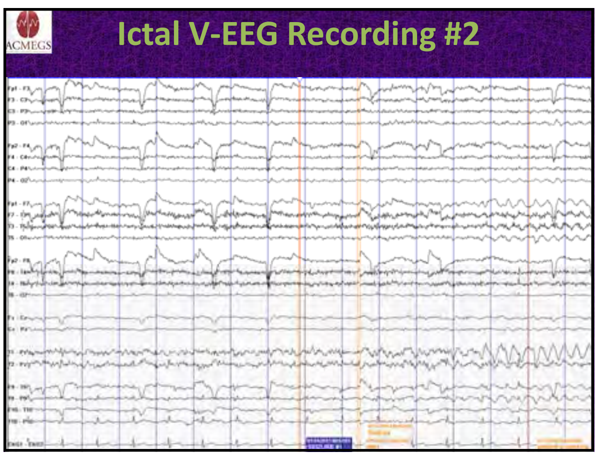
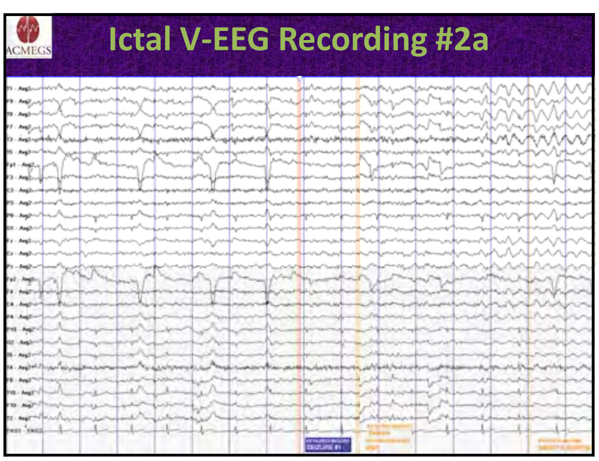
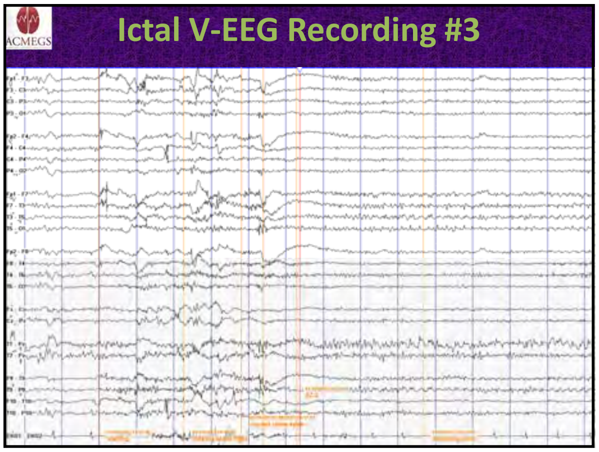
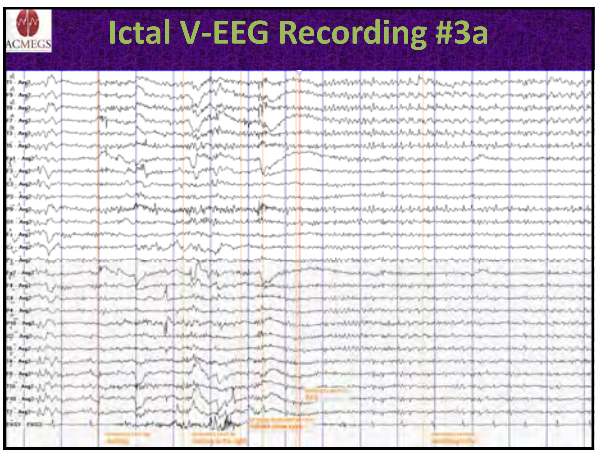
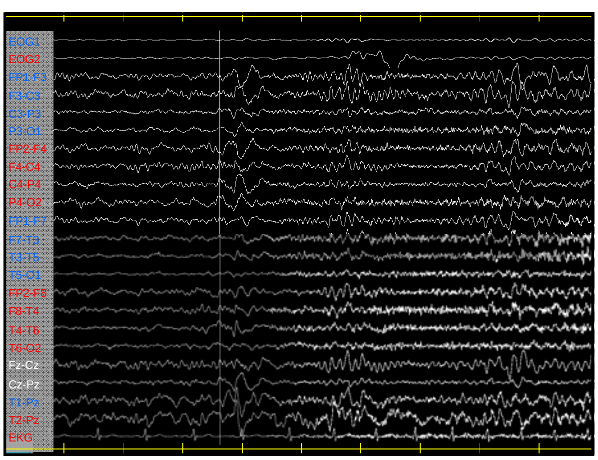

ACMEGS
Ictal V-EEG Recording #1

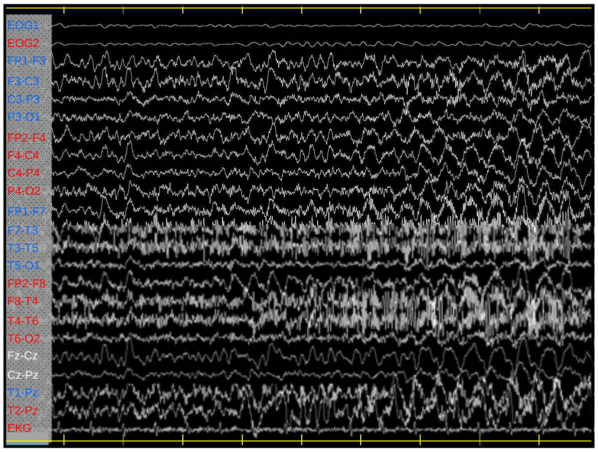

ACMEGS
Ictal V-EEG Recording #2

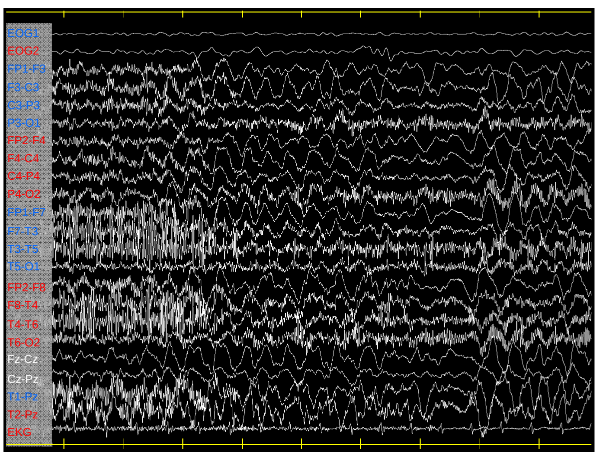

ACMEGS
Ictal V-EEG Recording #2a

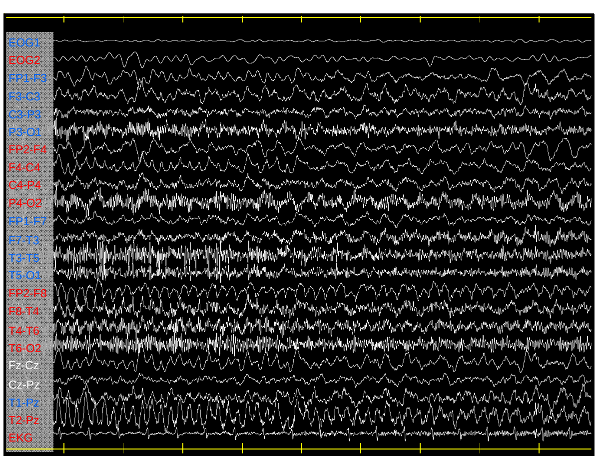

ACMEGS
Ictal V-EEG Recording #3


ACMEGS
Ictal V-EEG Recording #3a

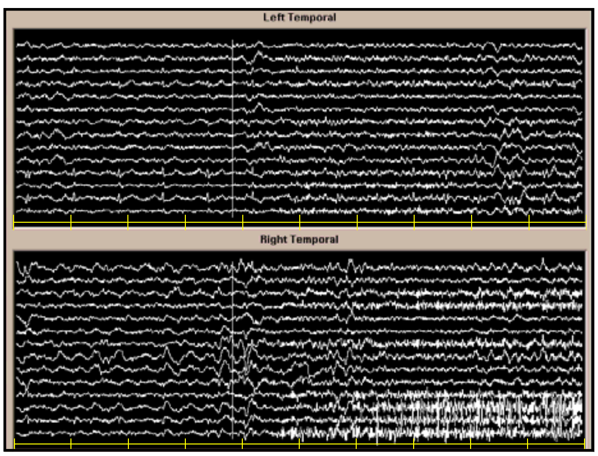

EOG1
EOG2
FP1-F3
F3-C3
C3-P3
P3-O1
FP2-F4
F4-C4
C4-P4
P4-O2
FP1-F7
F7-T3
T3-T5
T5-O1
FP2-F8
F8-T4
T4-T6
T6-O2
Fz-Cz
Cz-Pz
T1-Pz
T2-Pz
EKG

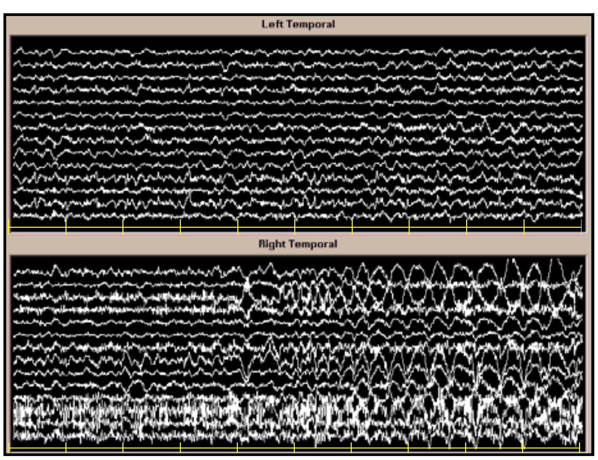

EOG1
EOG2
FP1-F3
F3-C3
C3-P3
P3-O1
FP2-F4
F4-C4
C4-P4
P4-O2
FP1-F7
F7-T3
T3-T5
T5-O1
FP2-F8
F8-T4
T4-T6
T6-O2
Fz-Cz
Cz-Pz
T1-Pz
T2-Pz
EKG


EOG1
EOG2
FP1-F3
F3-C3
C3-P3
P3-O1
FP2-F4
F4-C4
C4-P4
P4-O2
FP1-F7
F7-T3
T3-T5
T5-O1
FP2-F8
F8-T4
T4-T6
T6-O2
Fz-Cz
Cz-Pz
T1-Pz
T2-Pz
EKG

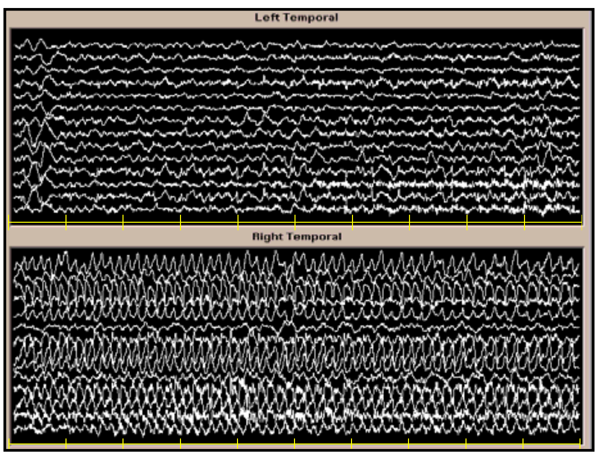

EOG1
EOG2
FP1-F3
F3-C3
C3-P3
P3-O1
FP2-F4
F4-C4
C4-P4
P4-O2
FP1-F7
F7-T3
T3-T5
T5-O1
FP2-F8
F8-T4
T4-T6
T6-O2
Fz-Cz
Cz-Pz
T1-Pz
T2-Pz
EKG

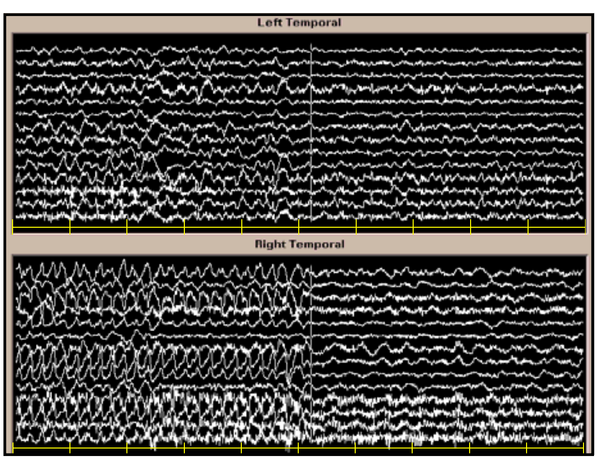

EOG1
EOG2
FP1-F3
F3-C3
C3-P3
P3-O1
FP2-F4
F4-C4
C4-P4
P4-O2
FP1-F7
F7-T3
T3-T5
T5-O1
FP2-F8
F8-T4
T4-T6
T6-O2
Fz-Cz
Cz-Pz
T1-Pz
T2-Pz
EKG


Left Temporal
Right Temporal


Left Temporal
Right Temporal


Left Temporal
Right Temporal


Left Temporal
Right Temporal


Left Temporal
Right Temporal

Ictal MEG Studies in PubMed on 12/01/12 (N = 20)

ACMEGS

Year	Author	Country	Patients	Seizures	Method	Lobe
1992	Stefan et al	Germany	**3**	3 x 1	ECD	**TL, FTL, TL**
1998	Ishibashi et al.	Japan	**1**	?	ECD	**FL**
2001	Shiraishi H.	Japan	**4**	4	ECD	**FL**
2002	Eliashiv et al.	USA	**7**	6 x 1	ECD	**FL , PL**
2002	Oishi et al	Japan	**1**	1	ECD	**Fusiform g.**
2002	Tilz et al.	Germany	**6 (13)**	?	ECD	**Mixed**
2003	Oishi et al	Japan	**1**	20	ECD	**TL**
2003	Tang et al.	USA	**5**	?	ECD	**FL, TPL, FPL**
2003	Asaaf et al.	USA	**7**	7 x 1	ECD	**TL, FL**
2004	Yoshinaga et al	Japan	**2**	"several"	ECD	**OL , FL**
2004	Tanaka	Japan	**1**	10 (2 recordings)	ECD	**FL**
2007	Mohamed et al.	Canada	**5**	6 x SE (4 + 2)	ECD	**Mixed**
2008	RamachandranNair et al	Canada	**5**	?	HFO	**FL**
2010	Xiang et al.	USA	**4**	3, ?	WBB	**FL, TL**
2010	Yagyu et al	Japan	**2**	2 x 2	STFT	**FL**
2011	Shiraishi et al.	Japan	**2**	1 + 1	ECD	**FL**
2012	Vaudano et al.	Europe	**1**	56 (reading e.)	ECD	**FL**
2012	Kakisaka et al.	USA	**1**	1	ECD (MC)	**FL**
2012	Fujiwara et al.	USA	**8 (20)**	20 x 1	Multiple	**FL, TL**
2012	Medvedovsky et al.	Finland/Izrael	**12(19/23/47)**	54	ECD	**Mixed**

ECD = equivalent current dipole, HFO = high frequency oscillations, WBN = Wavelet-based beamformer, STFT = short-time Fourier transform, T = temporal, F = frontal, O = occipital, P = parietal, L = lobe, SE = status epilepticus, MC = movement compensation.

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Epilepsia, 33(5):874–887, 1992
Raven Press, Ltd., New York
© International League Against Epilepsy

N = 3

Ictal and Interictal Activity in Partial Epilepsy Recorded with Multichannel Magnetoelectroencephalography: Correlation of Electroencephalography/Electrocorticography, Magnetic Resonance Imaging, Single Photon Emission Computed Tomography, and Positron Emission Tomography Findings

H. Stefan, §S. Schneider, *H. Feistel, |G. Pawlik, P. Schüler, §K. Abraham-Fuchs, T. Schlegel, †U. Neubauer, and ‡W. J. Huk

*Departments of Neurology, *Nuclear Medicine, †Neurosurgery, and ‡Neuroradiology, University of Erlangen-Nürnberg; §Medical Engineering Group, Siemens, Erlangen; and |Max-Planck-Institut of Neurological Research, Cologne, Germany*

Epilepsia **1992**;33(5):874-887.

Summary: Ictal and interictal epileptic activity was recorded for the first time by multichannel magnetoencephalography (MEG) in three patients with partial epilepsy. Pre- and intra-operative localization of the epileptogenic region was compared. The interictal epileptic activity was localized at the same region of the temporal or frontal lobe as the ictal activity. Main zones of ictal activity were shown to evolve from the tissue at the centers of interictal activity. Pre- and intra-operative electrocorticography (ECoG) as well as postoperative outcome confirmed localization in the temporal and frontal lobe. Results also correlated with findings from scalp EEG, interictal and ictal single photon emission computed tomography (SPECT), positron emission tomography (PET), and magnetic resonance imaging (MRI). Combined multichannel MEG/EEG recording permitted dipole localization of interictal and ictal activity. **Key Words:** Epilepsy—Seizure—Neurosurgery—Partial seizures—Magnetoencephalography—Electroencephalography—Positron emission tomography—Magnetic resonance imaging.

Epilepsy

N = 1

THREE-DIMENSIONAL LOCALIZATION OF SUBCLINICAL ICTAL ACTIVITY BY MAGNETOENCEPHALOGRAPHY: CORRELATION WITH INVASIVE MONITORING

Hideaki Ishibashi, M.D.,* Takato Morioka, M.D., Ph.D.,* Hiroshi Shigeto, M.D., Ph.D.,*† Shunji Nishio, M.D., Ph.D.,* Tomoya Yamamoto, M.D., Ph.D.,§ and Masashi Fukui, M.D., Ph.D.*

*Departments of *Neurosurgery and †Neurology, Neurological Institute, and §Department of Otolaryngology, Faculty of Medicine, Kyushu University, Fukuoka, Japan*

Ishibashi et al. Surg Neurol **1998**;50(2):157-63.

KEY WORDS

BACKGROUND
Although magnetoencephalography (MEG) provides accurate information on the spatial distribution and temporal patterns of the "interictal" epileptic activities, it is interictal in nature and therefore also prone to all the problems associated with interictal data.

METHODS
We investigated the subclinical "ictal" epileptic activity with a 37-channel, large-array biomagnetometer and mapped the data onto a three-dimensional image in a patient with intractable frontal lobe epilepsy. Dipole

The primary objective of a preoperative evaluation for epilepsy surgery is the accurate localization of the epileptogenic area. To meet this objective, localizing data are obtained from a variety of modalities including electrophysiological monitoring, anatomical imaging, and physiological imaging techniques, whereas invasive electrophysiological monitoring such as subdural and depth

N = 4

Interictal and Ictal Magnetoencephalographic Study in Patients with Medial Frontal Lobe Epilepsy

Hideaki Shiraishi, Yutaka Watanabe, Masako Watanabe, Yushi Inoue, Tateki Fujiwara, and Kazuichi Yagi

National Epilepsy Center, Shizuoka Higashi Hospital, Shizuoka, Japan

Summary: *Purpose:* To determine whether magnetoencephalography (MEG) has any clinical value for the analysis of seizure discharges in patients with medial frontal lobe epilepsy (FLE).

Methods: Four patients were studied with 74-channel MEG. Interictal and ictal electroencephalographic (EEG) and MEG recordings were obtained. The equivalent current dipoles (ECDs) of the MEG spikes were calculated.

Results: In two patients with postural seizures, interictal EEG spikes occurred at Cz or Fz. The ECDs of interictal MEG spikes were localized around the supplementary motor area. In the other two patients with focal motor or oculomotor seizures, interictal EEG spikes occurred at Fz or Cz. The ECDs of interictal MEG spikes were localized at the top of the medial frontal region. The ECDs detected at MEG ictal onset were also localized in the same area as those of the interictal discharges.

Conclusions: In medial FLE patients, interictal and ictal MEG indicated consistent ECD localization that corresponded to the semiology of clinical seizures. Our findings demonstrate that MEG is a useful tool for detecting epileptogenic focus. **Key Words:** MEG—Frontal lobe epilepsy—Medial cortex—Midline EEG spikes.

"In MEG studies, analysis of ictal discharges has been complicated by body movements during the seizure. However, we detected ictal activity on the MEG in all our patients. The ECDs derived from the spikes at MEG ictal onset, which often preceded clinical seizure onset, and closely corresponded to the tightly clustered ECDs derived from the interictal discharges. Thus the ictal MEG supports findings obtained from the interictal MEG".

N = 7

CME Ictal magnetic source imaging as a localizing tool in partial epilepsy

D.S. Eliashiv, MD; S.M. Elsas, MD; K. Squires, PhD; I. Fried, MD, PhD; and J. Engel, Jr., MD, PhD

Abstract—*Objective:* To determine the feasibility and usefulness of ictal magnetoencephalography (MEG) recordings in the presurgical evaluation of patients with epilepsy. *Methods:* Twenty patients with frequent or predictable seizures were studied with the intent to capture seizures using a large array single-probe 37-channel or dual-probe 74-channel biomagnetometer. *Results:* Successful ictal MEG recordings were made in 6 of 20 patients with neocortical epilepsy. In one other patient, a seizure was captured but movement artifact made MEG recordings impossible. As determined by invasive EEG recording and postsurgical outcome, ictal MEG provided localizing information that was superior to interictal MEG in three of the six patients. Localization of ictal onset by MEG was at least equivalent to invasive EEG in five of the six patients, and was superior in two patients as determined by postsurgical outcome. *Conclusion:* Larger studies are necessary to confirm that ictal MEG recordings in patients with frequent or easily provoked neocortical seizures can contribute localizing information equivalent or superior to invasive EEG recording.

NEUROLOGY 2002;59:1600–1610

For patients under consideration for epilepsy surgery, definition of the epileptogenic zone is of utmost importance in the planning of the resective strategy and to predict surgical outcome.

Magnetoencephalography (MEG) is a noninvasive recording technique closely linked to EEG, with EEG reflecting extracellular volume return currents and MEG reflecting intracellular currents.[1] MEG offers theoretical advantages that facilitate effective mod- … associated with interictal events, such as interictal epileptiform spikes, sharp waves, or focal slowing, whereas characterization of the ictal onset zone is regarded as most important in the delineation of the epileptogenic region. In most cases, MEG studies of patients with epilepsy are conducted on an outpatient basis, with the patients maintained on their therapeutic level of antiepileptic medication; therefore, ictal events are rare, and movement artifact …

Eliashiv et al. Neurology 2002;59(10);1600-10.

N = 1

Fusiform gyrus epilepsy: the use of ictal magnetoencephalography

Case report

Oishi et al. J Neurosurg 2002;97(1):200-4.

Makoto Oishi, M.D., Shigeki Kameyama, M.D., Nobuhito Morota, M.D., Masaru Tomikawa, M.D., Manabu Wachi, M.D., Akiyoshi Kakita, M.D., Ph.D., Hitoshi Takahashi, M.D., Ph.D., and Ryuichi Tanaka, M.D.

Departments of Neurosurgery and Psychiatry, National Nishi-Niigata Central Hospital; Department of Pathology, Brain Disease Research Center, and Department of Neurosurgery, Brain Research Institute, Niigata University, Niigata, Japan

The authors report successful presurgical identification of an epileptic focus in the fusiform gyrus by using ictal magnetoencephalography (MEG), which was performed with the aid of an advanced whole-brain neuromagnetometer. A 22-year-old man had suffered from medically refractory complex partial seizures since he was 10 years of age. Seizure symptoms, magnetic resonance imaging, and ictal single-photon emission computerized tomography examinations indicated right temporal lobe epilepsy; however, ictal electroencephalography, including sphenoidal recordings, failed even to lateralize the seizure focus. The MEG studies revealed that equivalent current dipoles of interictal activities were scattered bilaterally around the medial temporal structures, but those of ictal onset and postictal activities formed a cluster in the left fusiform gyrus. After confirmation of each ictal and interictal MEG finding by using long-term electrocorticography recordings, focal cortical resection of the left inferior temporal and fusiform gyri was performed. The histopathological diagnosis was cortical dysplasia, and the patient has achieved a good seizure outcome, now 15 months after the operation. Ictal and also postictal MEG may be more specific than interictal MEG for identifying the ictal onset zone.

Key Words • magnetoencephalography • fusiform gyrus • ictal recording • temporal lobe epilepsy • epileptic focus resection

N = 1

Fusiform gyrus epilepsy: the use of ictal magnetoencephalography

Case report

Oishi et al. J Neurosurg 2002;97:200–204.

MAKOTO OISHI, M.D., SHIGEKI KAMEYAMA, M.D., NOBUHITO MOROTA, M.D., MASARU TOMIKAWA, M.D., MANABU WACHI, M.D., AKIYOSHI KAKITA, M.D., PH.D., HITOSHI TAKAHASHI, M.D., PH.D., AND RYUICHI TANAKA, M.D.

Departments of Neurosurgery and Psychiatry, National Nishi-Niigata Central Hospital; Department of Pathology, Brain Disease Research Center; and Department of Neurosurgery, Brain Research Institute Niigata University, Niigata, Japan

The authors report successful presurgical identification of an epileptic focus in the fusiform gyrus by using ictal magnetoencephalography (MEG), which was performed with the aid of an advanced whole-brain neuromagnetometer. A 22-year-old man had suffered from medically refractory complex partial seizures since he was 10 years of age. Seizure symptoms, magnetic resonance imaging, and ictal single-photon emission computerized tomography examinations indicated right temporal lobe epilepsy; however, ictal electroencephalography, including sphenoidal recordings, failed even to lateralize the seizure focus. The MEG studies revealed that equivalent current dipoles of interictal activities were scattered bilaterally around the medial temporal structures, but those of ictal onset and postictal activities formed a cluster in the left fusiform gyrus. After confirmation of each ictal and interictal MEG finding by using long-term electrocorticography recordings, focal cortical resection of the left inferior temporal and fusiform gyri was performed. The histopathological diagnosis was cortical dysplasia, and the patient has achieved a good seizure outcome, now 15 months after the operation. Ictal and also postictal MEG may be more specific than interictal MEG for identifying the ictal onset zone.

KEY WORDS • magnetoencephalography • fusiform gyrus • ictal recording • temporal lobe epilepsy • epileptic focus resection

N = 13

Ictal onset localization of epileptic seizures by magnetoencephalography

Tilz C, Hummel C, Kettenmann B, Stefan H. Ictal onset localization of epileptic seizures by magnetoencephalography.
Acta Neurol Scand 2002: 106: 190–195. © Blackwell Munksgaard 2002.

C. Tilz, C. Hummel, B. Kettenmann, H. Stefan

Objective – The aim of this study was to localize the ictal onset zone of focal epileptic seizures by magnetoencephalography (MEG) and to compare the results with interictal MEG localizations, ictal and interictal electroencephalography (EEG) results and magnetic resonance imaging (MRI) in epilepsy surgery candidates. *Material and methods* – Data of 13 patients with partial seizures during MEG recording were analysed. Measurements were performed with a Magnes II dual unit system. *Results* – In six of 13 cases, the ictal onset zone could be localized by MEG, with all interictal MEG findings being confirmed by ictal MEG results. In four cases, the ictal MEG localization results were corresponding to the ictal EEG localization results. In two cases, EEG yielded no comparable information. *Conclusion* – Ictal onset localization is feasible with MEG. Both interical and ictal MEG contribute valuable information to the presurgical assessment of epilepsy patients.

N = 7

Ictal Magnetoencephalography in Temporal and Extratemporal Lobe Epilepsy

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Department of Neurology, The University of Illinois—Peoria, Peoria, Illinois; †Departments of Neurology and ‡Neurosurgery, University of California, and §California Pacific Medical Centre, San Francisco, California, U.S.A.

Summary: *Purpose:* We evaluated visual patterns and source localization of ictal magnetoencephalography (MEG) in patients with intractable temporal lobe epilepsy (TLE) and extratemporal epilepsy (ETE).

Methods: We performed spike and seizure recording simultaneously with EEG and MEG on two patients with TLE and five patients with ETE. Scalp EEG was recorded from 21 channels (10-20 international system), whereas MEG was recorded from two 37-channel sensors. We compared ictal EEG and MEG onset, frequency, and evolution and performed MEG dipole source localization of interictal spikes and early ictal discharges and coregistered dipoles to brain magnetic resonance imaging (MRI). We correlated dipole characteristics with intracranial EEG, surgical resection, and outcome.

Results: Ictal MEG lateralized seizure onset in both TLE patients and demonstrated ictal onset, frequency, and evolution in accordance with EEG. Ictal MEG source analysis revealed tangential vertical dipoles in the anterolateral angle in one patient, and anterior dipoles with anteroposterior orientation in the other. Intracranial EEG revealed regional entorhinal seizure onset in the first patient. Both patients became seizure free after temporal lobectomy. In ETE, ictal MEG demonstrated visual patterns similar to ictal EEG and had concordant localization with interictal MEG in all five patients. Two patients underwent surgery. Ictal MEG localization was concordant with intracranial EEG in both cases. One patient had successful outcome after surgery. The second patient did not improve after limited resection and multiple subpial transections.

Conclusions: Ictal MEG can demonstrate ictal onset frequency and evolution and provide useful localizing information before epilepsy surgery. **Key Words:** MEG—Ictal—Temporal—Extratemporal—Epilepsy.

SHORT REPORT

N = 1

Ictal magnetoencephalographic discharges from elementary visual hallucinations of status epilepticus

M Oishi, H Otsubo, S Kameyama, M Wachi, K Tanaka, H Masuda, R Tanaka

Purpose: To report the rare opportunity to study ictal magnetoencephalography (MEG) in a 26 year old man with simple partial status epilepticus that presented as elementary visual hallucinations (EVHs) in the right upper visual field.
Methods: The patient described his EVHs as "snowing on TV," "flickering lights," and "rotating coloured balls" that continued for several days. MEG and simultaneous EEG were recorded twice: during an episode of EVHs (ictal recordings) and after EVHs were controlled by medications (interictal recordings).
Results: During EVHs, MEG showed continuous periodic epileptiform discharges over the left posterior superior temporal region, while simultaneous EEG showed rhythmic theta waves and sporadic spikes over the left temporal region. The MEG discharge consisted of a three phase spike complex. Equivalent current dipoles (ECDs), modelled from spike complexes, localised in the left superior temporal area. After drug treatment controlled the EVHs, interictal MEG and EEG showed rare spikes over the same left temporal region. The average ictal ECD moment (mean (SD)) (128.7 (32.8 nAm)) was significantly weaker than the average interictal ECD moment (233.0 (63.9) nAm) (p<0.05).
Conclusions: The continuous, periodic, and clustered discharges seen on ictal MEG were the sources of EVH. The weaker ictal ECD sources were frequently not detected by scalp EEG, while the stronger interictal sources, presumably originating from an extensive interictal zone, were sufficiently large to be seen as EEG spikes.

CASE REPORT

SIMULTANEOUS MEG AND EEG

N = 5

Consistency of interictal and ictal onset localization using magnetoencephalography in patients with partial epilepsy

J Neurosurg **2003**;98(4);837-45.

Lilly Tang, M.D., Mary Mantle, R.EEG.T., Paul Ferrari, B.A., Hagen Schiffbauer, M.D., Howard A. Rowley, M.D., Nicholas M. Barbaro, M.D., Mitchel S. Berger, M.D., and Timothy P. L. Roberts, Ph.D.

Departments of Radiology and Neurological Surgery, University of California at San Francisco, California; and Department of Neurosurgery, University of Tübingen, Germany

Object. The aim of this study was to evaluate the spatial accuracy of interictal magnetoencephalography (MEG) in localizing the primary epileptogenic focus in comparison with alternative MEG-derived estimates such as ictal onset recording or sensory mapping of the periphery where seizures manifest.

Methods. During this retrospective study of 12 patients with epilepsy who had undergone successful magnetic source (MS) imaging with the aid of a dual 37-channel biomagnetometer as well as simultaneous MEG electroencephalography (EEG) recordings, ictal events were observed in five patients and quantitative comparisons of interictal spike and ictal seizure onset source localizations were made. In the eight patients who had presented with sensorimotor seizure, source localization of cortical sites concordant with seizure foci was determined using somatosensory functional mapping, and the results were quantitatively compared with interictal spike source localizations.

Interictal spike sources demonstrated on MEG localized to the same region as the corresponding ictal event or somatosensory source localizations. The mean distance between the ictal foci and interictal spike sources was 1.1 ± 0.3 cm. Results of functional somatosensory mapping in patients with sensorimotor seizures demonstrated that seizure sources consistently colocalized with interictal MEG spike sources, with a mean distance of 1.5 ± 0.4 cm. No systematic directional bias was observed. Interictal sources tended to be tightly clustered, and the mean ellipsoid volume, defined by one standard deviation of the source spatial coordinates, was 1 cm³.

Conclusions. Interictal spike localizations on MEG were concordant with ictal and, where relevant, functional somatosensory mapping localizations. These findings support the interpretation of interictal spikes on MEG as a useful and effective noninvasive method for localizing primary seizure foci.

Key Words • magnetoencephalography • magnetic source imaging • epilepsy • presurgical mapping • seizure • ictal spike • interictal spike

SHORT REPORT

N = 1

Ictal magnetoencephalographic study in a patient with ring 20 syndrome

N Tanaka, K Kamada, F Takeuchi

J Neurol Neurosurg Psychiatry 2004;75:488–490. doi: 10.1136/jnnp.2003.029438

Objective: To report the ictal magnetoencephalography (MEG) in a patient with ring chromosome 20 mosaicism, a rare chromosomal anomaly associated with intractable epilepsy.
Methods: MEG and simultaneous EEG were recorded with a 204 channel whole head MEG system. Ten habitual seizures occurred during the acquisition, which was done twice. The equivalent current dipoles (ECDs) for ictal discharges on MEG were calculated using a single dipole model. The ECDs were superimposed on a magnetic resonance image.
Results: During the seizures, EEG showed prolonged bursts of 5–6 Hz high voltage slow waves with spike components, dominantly in the bilateral frontal region. MEG showed epileptiform discharges corresponding to the ictal EEG. Ictal discharges on MEG were dominant in the frontal area in the initial portion, and then spread in the bilateral temporal areas in the middle of the seizure. ECDs obtained from the spikes of the initial portion were clustered in the medial frontal lobe.
Conclusions: The source of the ictal MEG was localised in the medial frontal lobe. The findings suggest that the mechanism underlying epilepsy in this case might be similar to medial frontal lobe epilepsy. Ictal MEG is a valuable tool for detecting the site of seizure onset.

MEG FINDINGS

Magnetoencephalography for surgical treatment of refractory status epilepticus

N = 5

I. S. Mohamed[1], H. Otsubo[1], E. Donner[1], A. Ochi[1], R. Sharma[1], J. Drake[2], J. T. Rutka[2], S. H. Chuang[3], S. Holowka[3], O. C. Snead III[1]

Mohamed et al.
Acta Neurol Scand 2007;115 (Suppl. 186);29–36.

Epilepsy Research (2008) 78, 216–224

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journal homepage: www.elsevier.com/locate/epilepsyres

N = 5

Epileptic spasms in older pediatric patients: MEG and ictal high-frequency oscillations suggest focal-onset seizures in a subset of epileptic spasms

Rajesh RamachandranNair[a,*], Ayako Ochi[a], Katsumi Imai[a], Mony Benifla[b], Tomoyuki Akiyama[a], Stephanie Holowka[c], James T. Rutka[b], O. Carter Snead III[a], Hiroshi Otsubo[a]

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Epilepsy Research (2010) 90, 199–206

ELSEVIER

journal homepage: www.elsevier.com/locate/epilepsyres

N = 2

The applications of time-frequency analyses to ictal magnetoencephalography in neocortical epilepsy

Kazuyori Yagyu[a,*], Fumiya Takeuchi[b], Hideaki Shiraishi[a], Shingo Nakane[c], Keitaro Sueda[a], Naoko Asahina[a], Shinobu Kohsaka[a], Shuichi Umeoka[d], Naotaka Usui[d], Koichi Baba[d], Shinji Saitoh[a]

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Received 14 June 2009; received in revised form 13 January 2010; accepted 2 May 2010
Available online 1 June 2010

Epilepsy Research (2012) 101, 191–196

N = 1

ELSEVIER

journal homepage: www.elsevier.com/locate/epilepsyres

SHORT COMMUNICATION

Clinical evidence for the utility of movement compensation algorithm in magnetoencephalography: Successful localization during focal seizure

Yosuke Kakisaka[a,b,*], Zhong I. Wang[a], John C. Mosher[a], Anne-Sophie Dubarry[a], Andreas V. Alexopoulos[a], Rei Enatsu[a], Prakash Kotagal[a], Richard C. Burgess[a]

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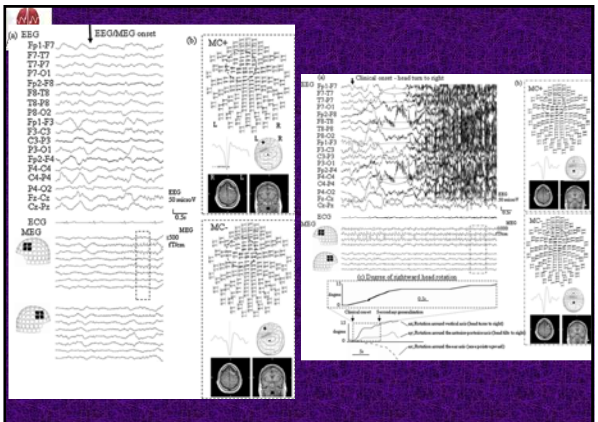
Received 30 December 2011; received in revised form 11 March 2012; accepted 18 March 2012
Available online 14 April 2012



Kakisaka et al. Epilepsy Res 2012;101(1-2);191-6.

Bagić 2013

N = 1

Networks involved in seizure initiation

A reading epilepsy case studied with EEG-fMRI and MEG

Vaudano et al. Neurology **2012**;79(3):249-53.

Anna E. Vaudano, PhD
David W. Carmichael, PhD
Afraim Salek-Haddadi, PhD
Stefan Rampp, PhD
Hermann Stefan, PhD
Louis Lemieux, PhD
Matthias J. Koepp, PhD

ABSTRACT

Objective: To define the ictal cortical/subcortical network of reading-induced seizures.

Methods: We analyzed ictal magnetoencephalography (MEG) and EEG-correlated fMRI (EEG-fMRI) data in a unique patient with reading epilepsy (RE) affected by frequent perioral reflex myoclonì triggered by reading silently.

Results: Ictal MEG corroborated EEG localization and revealed activity extending precentrally into Brodmann area (BA) 6. fMRI blood oxygen level–dependent (BOLD) signal changes in the left deep piriform cortex (PFC) and left BA6 preceded seizures and occurred before BOLD changes were observed in thalamus and right inferior frontal gyrus (BA44). Dynamic causal modeling provided evidence of a causal link between hemodynamic changes in the left PFC and reading-evoked seizures.

Conclusion: Our findings support the important role of deep cortical and subcortical structures, in particular the frontal PFC, as key regions in initiating and modulating seizure activity. In our patient with RE, BA6 appeared to be the area linking cognitive activation and seizure activity.

Neurology® 2012;79:249–253

GLOSSARY

BA = Brodmann area; **BOLD** = blood oxygen level–dependent; **GLM** = general linear model; **MEG** = magnetoencephalography; **ORM** = oral reflex myoclonus; **PFC** = piriform cortex; **RE** = reading epilepsy; **ROI** = region of interest.

FULL-LENGTH ORIGINAL RESEARCH

N = 26 (12)

Sensitivity and specificity of seizure-onset zone estimation by ictal magnetoencephalography

*†Mordekhay Medvedovsky, ‡Samu Taulu, ||Eija Gaily, ||Eeva-Liisa Metsähonkala, †Jyrki P. Mäkelä, ¶Dana Ekstein, #**Svetlana Kipervasser, #**Miri Y. Neufeld, **††Uri Kramer, ‡‡Göran Blomstedt, **§§¶¶Itzhak Fried, ‡‡Atte Karppinen, §§Igor Veshchev, ##Reina Roivainen, ** ***Bruria Ben-Zeev, **†††Hadassah Goldberg-Stern, †Juha Wilenius, and ‡‡‡Ritva Paetau

Medvedovsky et al. Epilepsia 2012;53(9):1649-57.

SUMMARY

Purpose: Ictal video–electroencephalography (EEG) is commonly used to establish ictal onset-zone location. Recently software development has enabled systematic studies of ictal magnetoencephalography (MEG). In this article, we evaluate the ability of ictal MEG signals to localize the seizure-onset zone.

Methods: Twenty-six patients underwent ictal MEG and epilepsy surgery. Prediction of seizure-onset zone by ictal and interictal MEG was retrospectively compared with ictal-onset area found by intracranial EEG in 12 patients. The specificity and sensitivity of the prediction were calculated at hemisphere-lobe (HL) and at hemisphere-lobe-surface (HLS) levels.

Key Findings: The sensitivity of ictal MEG source localization was 0.958 on HL and 0.706 on HLS levels, and its specificity was 0.900 on HL and 0.731 on HLS levels. The interictal MEG dipole cluster, defined as >10 dipoles on one lobar surface, had sensitivity of 0.400 and specificity of 0.769. Ictal MEG was equally sensitive and specific on dorsolateral and nondorsolateral neocortical surfaces up to a depth of 4 cm from the scalp.

Significance: Sources of ictal-onset MEG signals and interictal dipole clusters are essentially equally specific in estimation of the ictal-onset zone on lobar surface resolution, but ictal MEG is more sensitive. On the lobe resolution, ictal MEG estimates ictal-onset zone with high sensitivity and specificity.

KEY WORDS: Epilepsy, Magnetoencephalography, Presurgery workup.

Maximizing Promises of Ictal MEG

- 1. Learning how to maximize localizing value:
  - Not all spikes are created equal…
- 2. Broaden zones of personal comfort with seizures:
  - More openness to active facilitation…
- 3. Discerning when it has a higher clinical value:
  - Suboptimal V-EEG, SPECT, PET…
- 4. Standardizing methodological approaches:
  - Sharing experience, multicenter studies…
- 5. Exploring new methods and their rational integration in presurgical evaluation.

Bagić 2013

Workshop: Ictal MEG

Methodological and Clinical Aspects of Ictal MEG

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Helsinki, Finland

Ritva Paetau

Methodological and Clinical Aspects of ictal MEG

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Ictal & inter-ictal Video-MEG acquisition and analysis at HUCH

- ***Indication***
  - ***to localize the seizure-onset zone in epilepsy surgery candidates***
- ***Typical problems***
  - ***conflicting or non-localizing results from video-EEG, FDG-PET, SPECT, MRI.***
  - ***to aid the modelling of an EEG spike***
  - ***to localize functional sensori-motor or language areas***

BioMag laboratory
Ictal MEG 2007 - 2012 (5 yrs: 30-40/y)

All epilepsy surgery candidates with MEG	***156***
Successful Ictal recording	***41 (26 %)***
Mean time until 1st seizure	***7,8 h***
Median	***6,3 h***
Range	***1 – 40 h***

History of Ictal MEG 1987 à 2005

- ***First ictal MEG recordings (4)*** *Sutherling et al 1987.*
- ***Ictal and inter-ictal signals had identical sources (N=23).*** *Shiraishi et al. 2001, Tang et al. 2003, Assaf et al. 2003.*
- ***Ictal and inter-ictal MEG give non-redundant information (N=20)*** *Eliashiv et al. 1999, Tilz et al. 2002.*
- ***The need of long immotility during MEG made ictal MEG unpractical..... until 2006***

Patient preparation:

FLAT EEG electrodes essential to enable long painless recordings
The cap fixes the position of 4 HPI coils, which must be attached high enough to remain inside the helmet in case the patient's head moves partly out.

The head deep enough to cover basal frontal areas.

The bed plate enables rapid and safe removal of the head from helmet in case of big motor seizure.

Acquisition 3 or 6 hours

- ***Functional landmarks***
  - *(SEF, AEF, VEF, motor cx, at least 2 modalities)*
- ***Monitoring:***
  - *Continuous head position*
  - *Audio-Video recording*
  - *ECG, O2-saturation, vigilance*
- ***Activations***
  - *Inter-ictal activity: wake, hyperventilation, and sleep*
  - *Ictal activity sleep deprivation, AED reduction*
- ***In the shielded room:***
  - *Accompaning person*
  - *Emergency medication*

Signal analysis

- All data maxfiltered (tSSS)
- Visual screening of the Video-MEG signal:
  - recognition of epileptiform signals and/or seizure-related pathological rhythms
  - recognition of ictal onset timing and activity
- Dipole analysis, NeuroMag SourceModelling
  - BESA occasionally
  - MNE occasionally
  - Beamforming: maybe in future

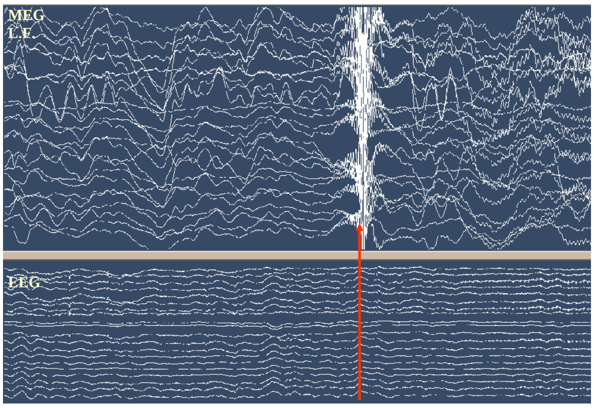
Some new tools for ictal MEG

1. temporal Signal Space Separation (tSSS), continuous head position monitoroing to enable moderate degree of movement during long recordings
Taulu et al. 2005-2006

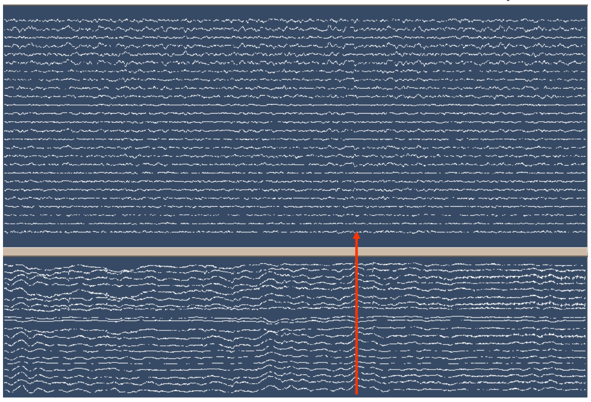
2. Suppression of uncorrellated sensor noise and artifacts, to enhance the signal-to-noise ratio in the beginning of a seizure
Taulu and Helle, in preparation

3. Integrated Video-MEG, 2 infra-red cameras, for accurate timing of ictal and other events
Zhdanov et al. 2008 à

Original data: onset of 30-Hz VNS stimulation, 5 s

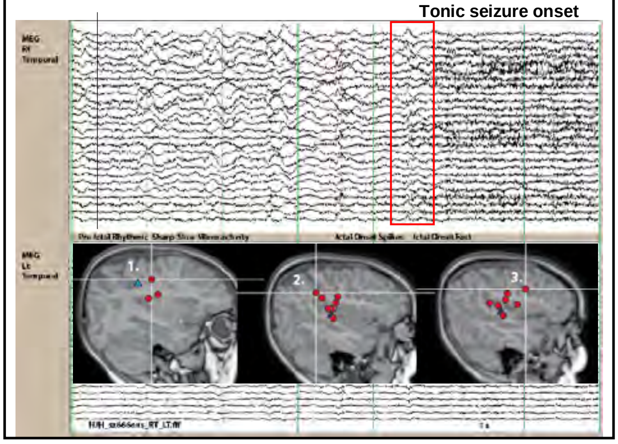


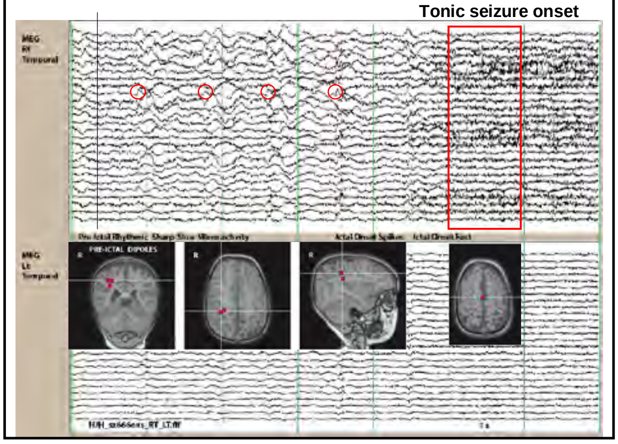
***after tSSS**: onset of 30-Hz VNS stimulation, 5 s*



Healthy until 6y, then 3-month period of nearly continuous left-arm-onset tonic seizures

Tonic seizure onset

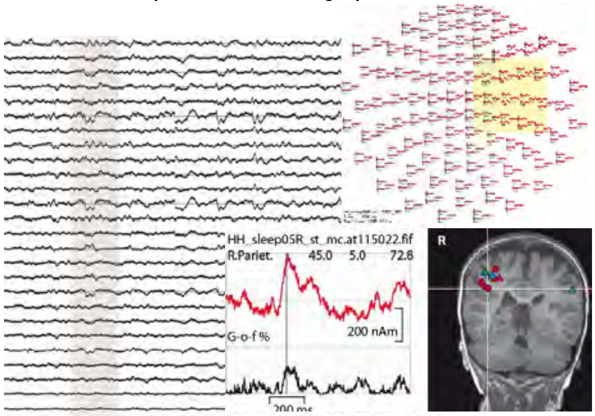


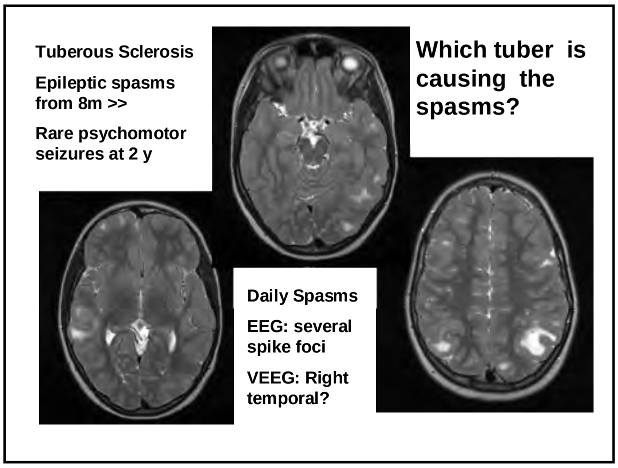


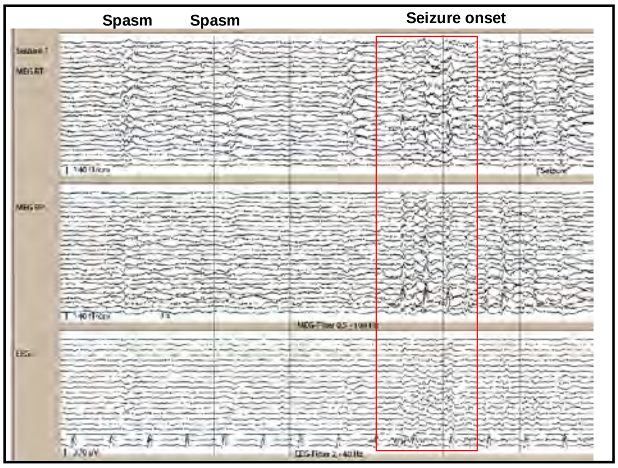
Conclusion from ictal recording of patient 1:

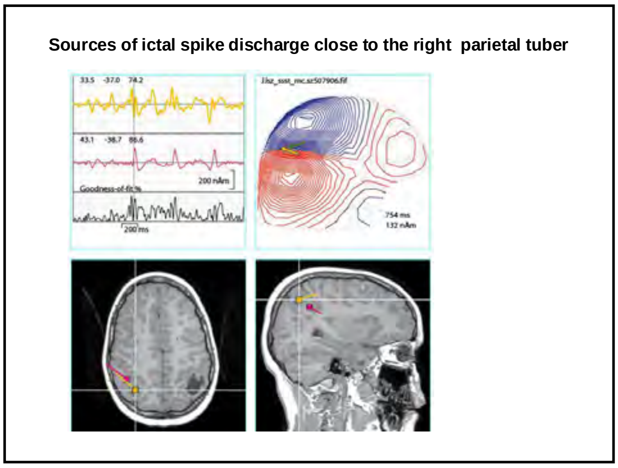
- ***Multiple sources and complex networks at the onset of motor seizure already may represent propagated activity***
- ***In FCD, the inter-ictal activity is often more local, than the ictal discharges.***
- ***Later, the seizures of patient 1 had stopped and an inter-ictal MEG was acquired..***

Focal inter-ictal spike sources in the right postcentral sulcus

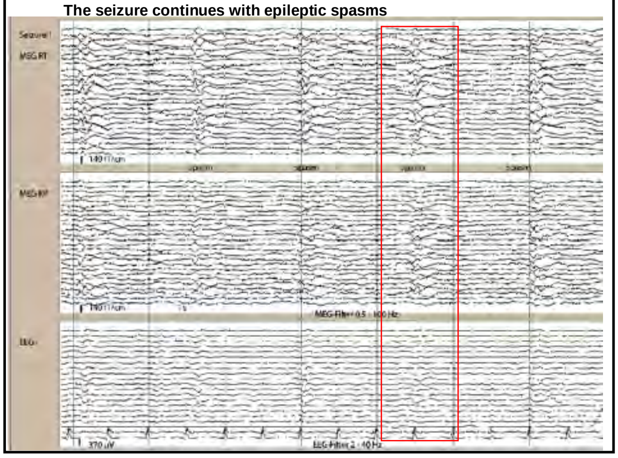



Tuberous Sclerosis
Epileptic spasms from 8m >>
Rare psychomotor seizures at 2 y
Which tuber is causing the spasms?
Daily Spasms
EEG: several spike foci
VEEG: Right temporal?

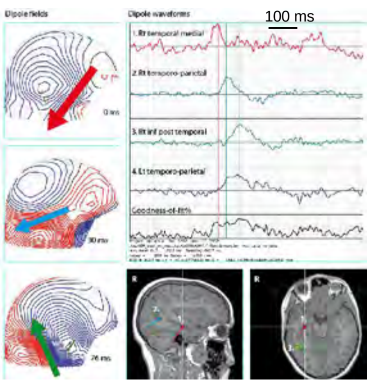

Spasm
Spasm
Seizure onset


Sources of ictal spike discharge close to the right parietal tuber

The seizure continues with epileptic spasms



Complex field patterns and source configurations during spasm



Contribution from sources in both temporal lobes

Also the Right parietal tuber participates into the spasm

Ictal EEG Right Temporal lobe dominant

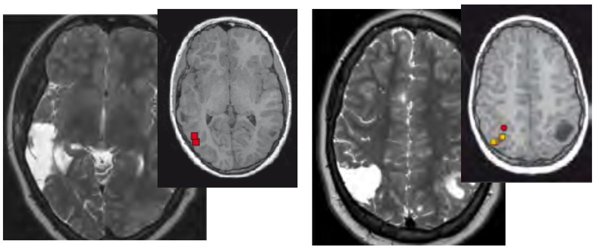
è both the right parietal and the right temporal tuber were removed

è complete cessation of spasms

Right temporal and parietal tubers resected. Intraoperative ECoG showed intensive spiking in the tissue between the 2 tubers.

No spasms since surgery, (4,5 y), psychomotor szs 1-2/y.

Spells of vertigo without EEG change since age of 16.



When to record ictal MEG?

- ***Even a long recording is worth-while, if there is no good hypothesis about the seizure onset area***
  - ***normal MRI and ictal EEG, or***
  - ***multiple foci on MRI and ictal EEG (e.g. Tuberous sclerosis)***

Workshop: Ictal MEG

Ictal Events Simultaneously Modeled by MEG and EEG

John Ebersole, M.D.
Adult Epilepsy Center, University of Chicago Medical Center, Chicago, IL

Concurrent Source Modeling of MEG and EEG Seizures

John S. Ebersole

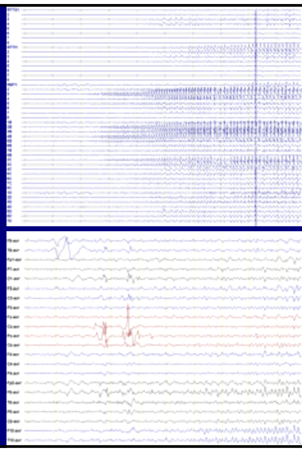
Illinois MEG Center, Alexian Brothers Medical Center
&
The University of Chicago

Clinical Value of Seizure Recording

- Interictal spike foci are not necessarily the origins of seizures
- Patients may have multiple spike foci, but only one epileptogenic focus
- Ictal recordings can confirm the lateralization and at times localization of seizure onset
- Considered the gold-standard for pre-surgical evaluations

Ictal MEG and EEG Fields

- Cerebral ictal onset is often very focal and low amplitude and produces no recordable MEG or scalp EEG fields
- The first recognizable ictal rhythms commonly come after propagation and recruitment of adjacent cortex
- Models of ictal waveforms may not localize the seizure origin as well as thought

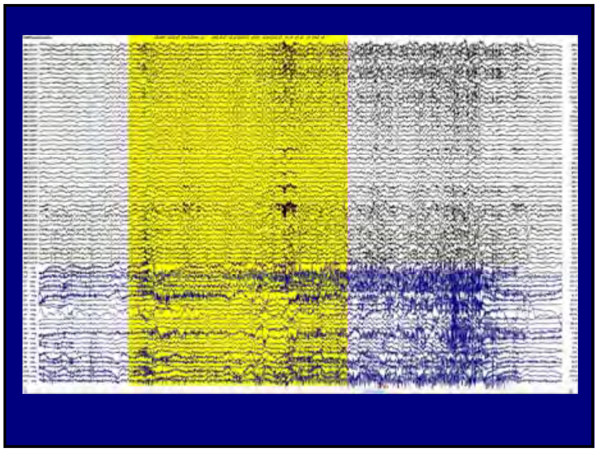


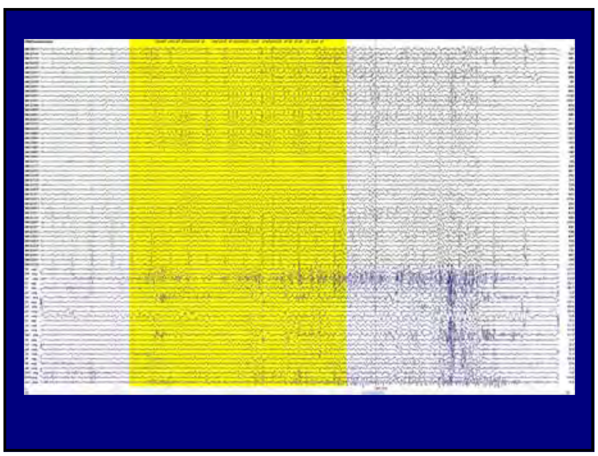
Techniques of Seizure Modeling

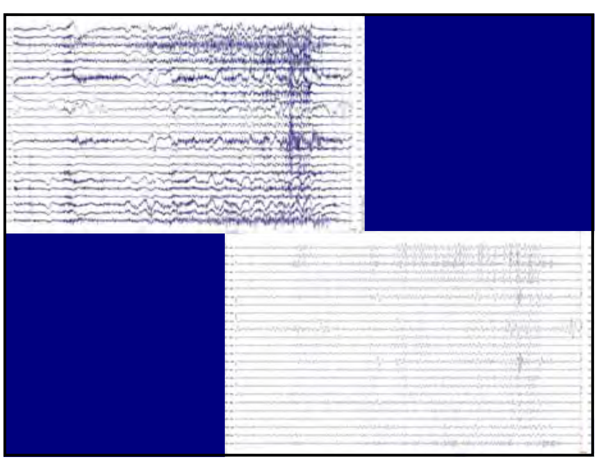
- Seizures are often accompanied by movement and muscle artifact
- Only the first few seconds of a seizure may be without artifact and head movement
- Regardless, selective bandpass filtering is essential prior to source modeling

Techniques of Seizure Modeling

- Tight bandpass filter settings are best
- MEG and EEG seizures have characteristic frequencies that define the lowpass filter
- High pass filters stabilize the baseline
- For temporal lobe seizures – 2-15 Hz
- For extra-temporal seizures – 2 -25 Hz
- Only intracranial seizures have higher frequencies

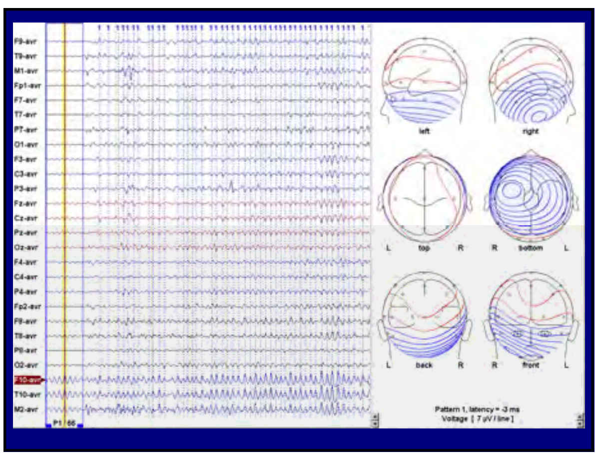


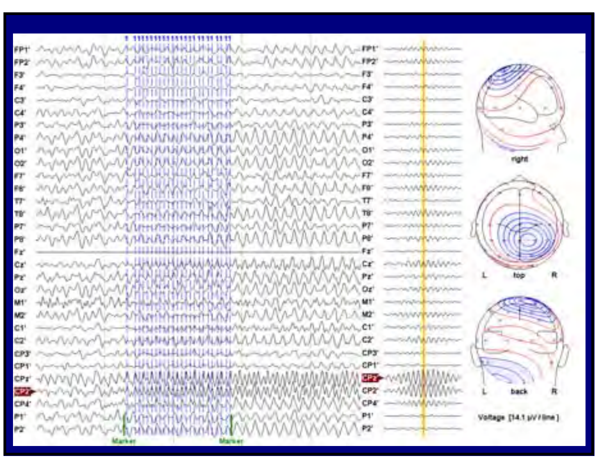




Techniques of Seizure Modeling

- Model earliest recognizable rhythm before substantial propagation
- Average sequential ictal waveforms over short period of field stationarity
- Employ same principles as spike dipole modeling on averaged ictal waveform of higher S/N



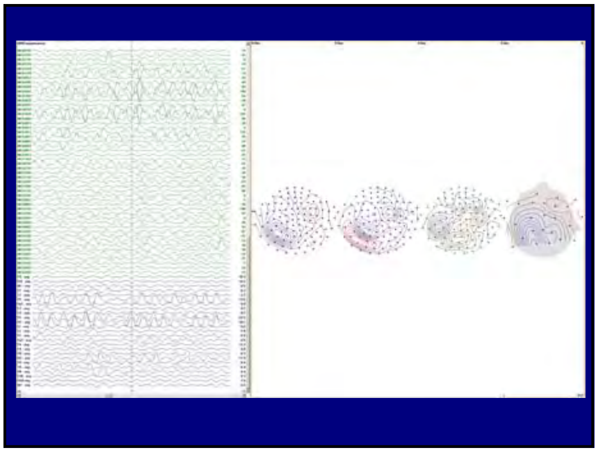


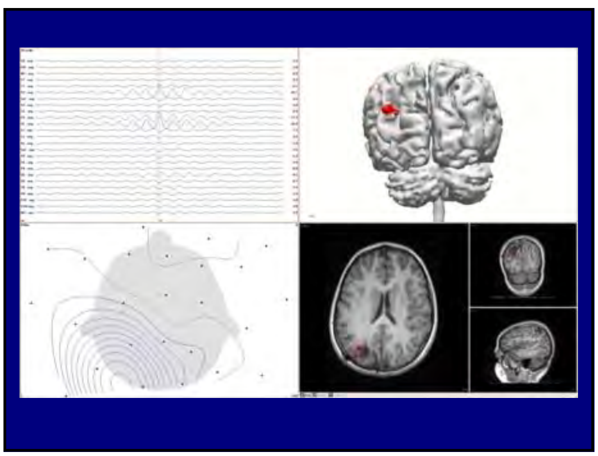
Technique of Seizure Modeling

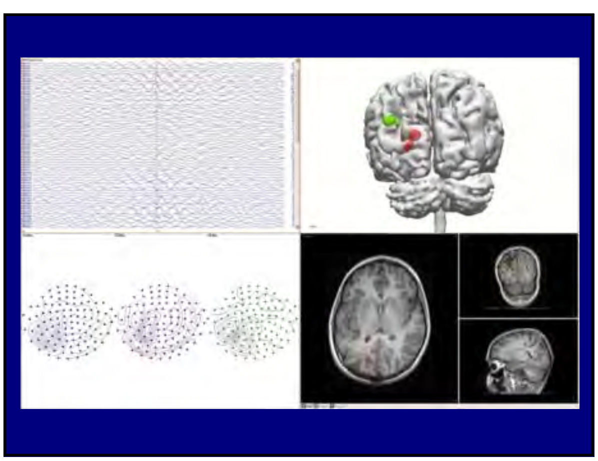
- Average and model both MEG and EEG waveforms
- Just as with spikes MEG will identify the tangential ictal field component
- EEG will preferentially identify the radial ictal field component
- As with spikes, there may be both or only one

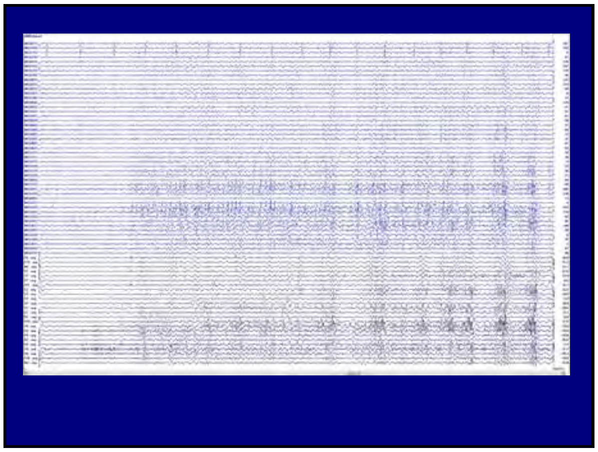
Ictal Interpretation Scenarios

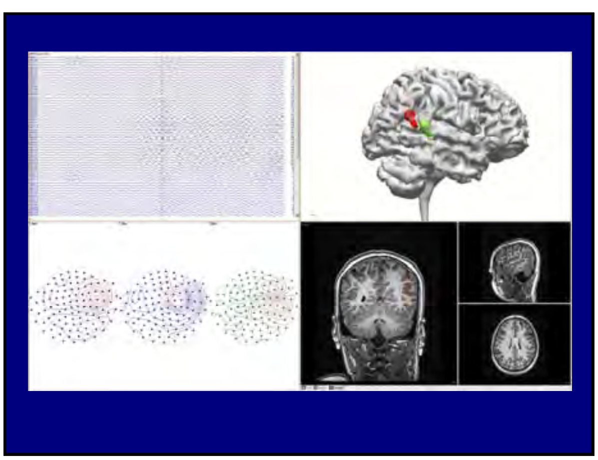
- MEG and EEG seizures are equally well visualized
- Dipole models of both provide nearly the same localization
- MEG characterizes the tangential field, EEG the radial and/or tangential field

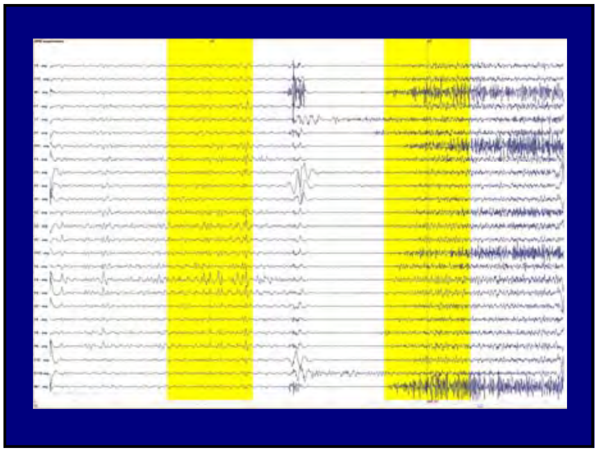


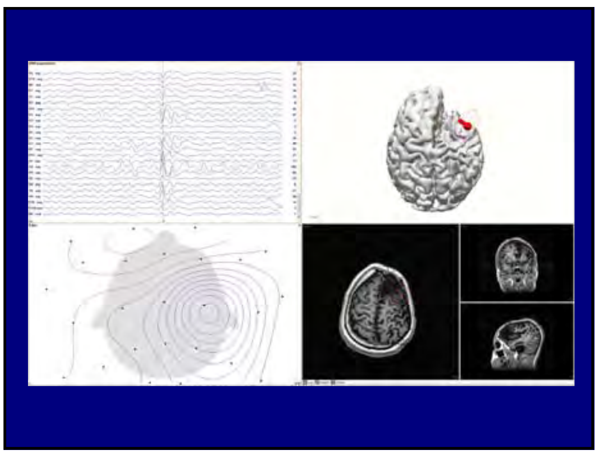


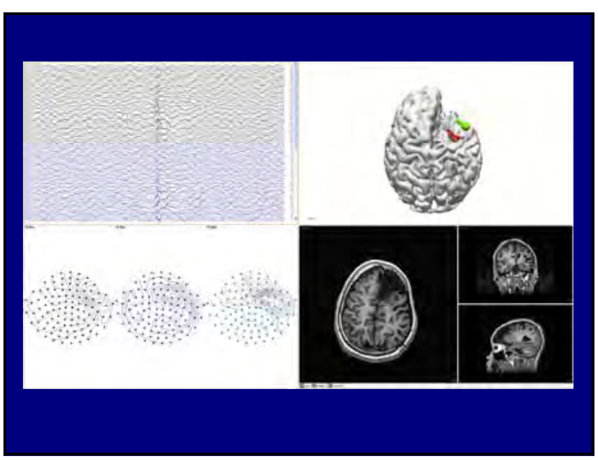


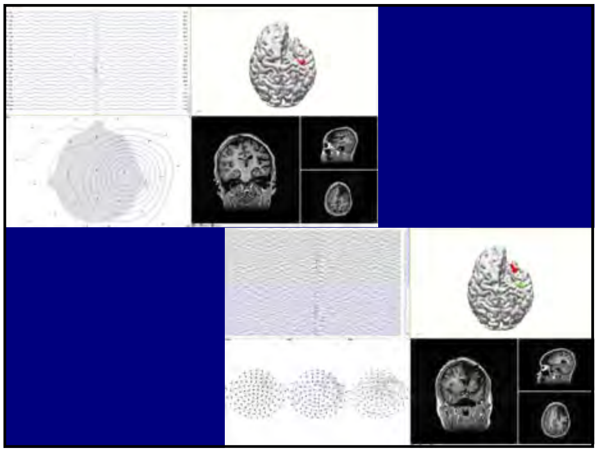






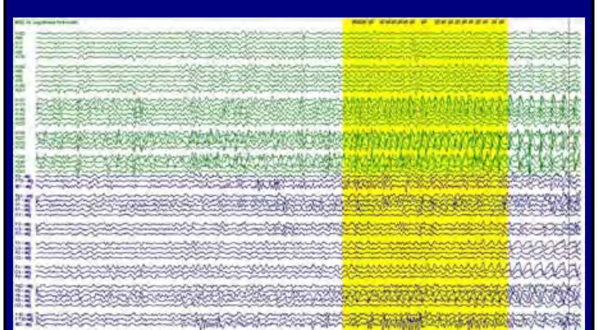


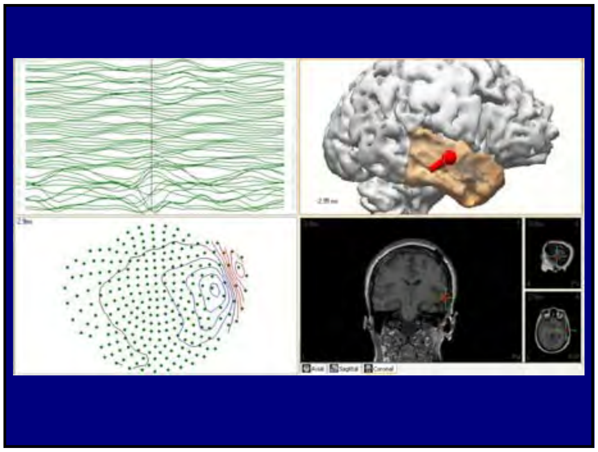


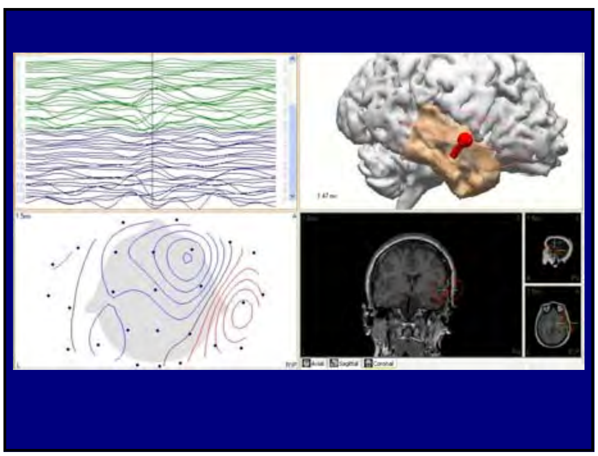


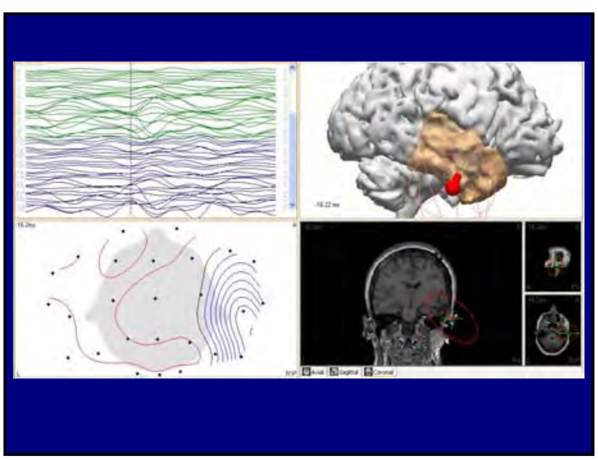
Ictal Interpretation Scenarios

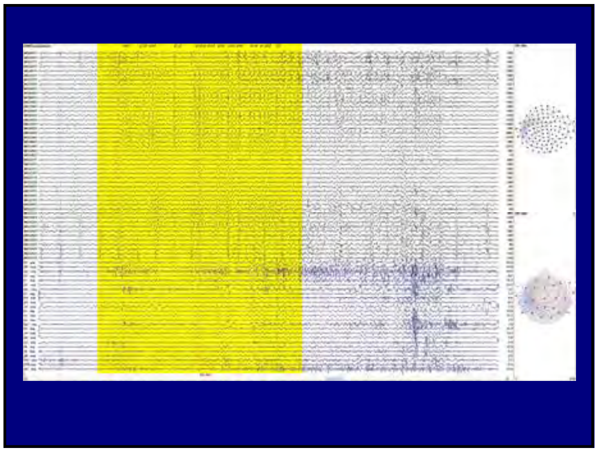
- MEG seizure is better visualized or lateralized than EEG seizure
- MEG shows a better or earlier tangenial ictal component
- MEG source localization is more accurate

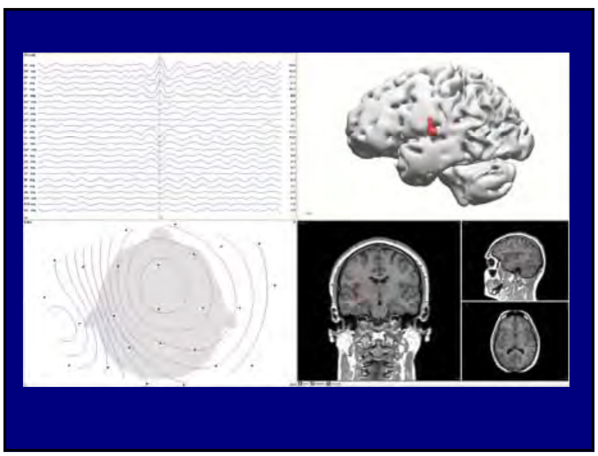


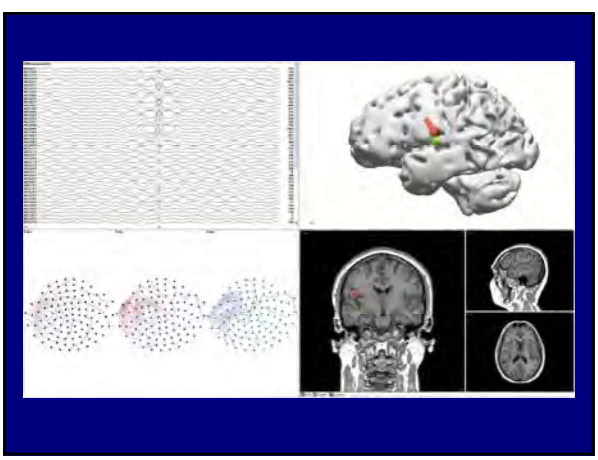


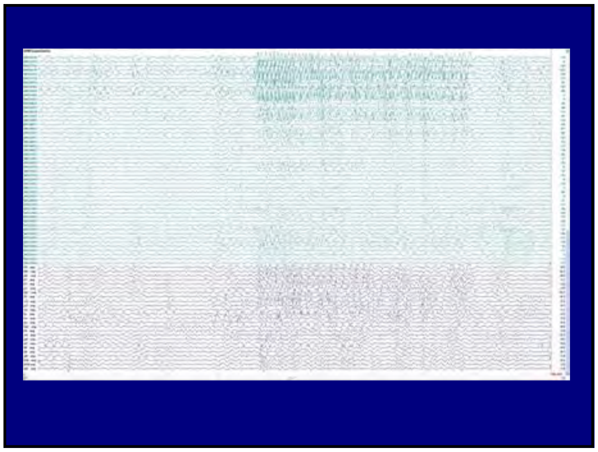


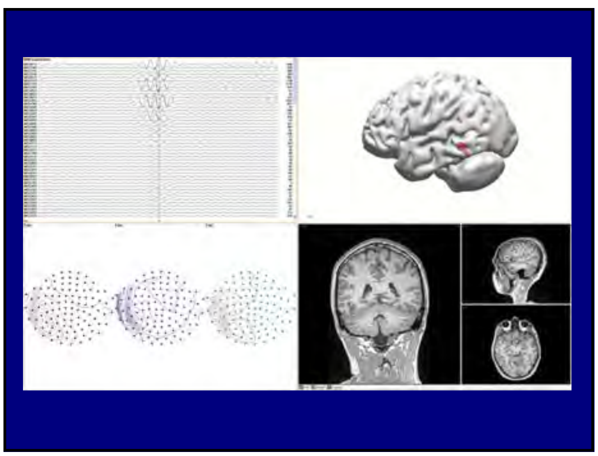


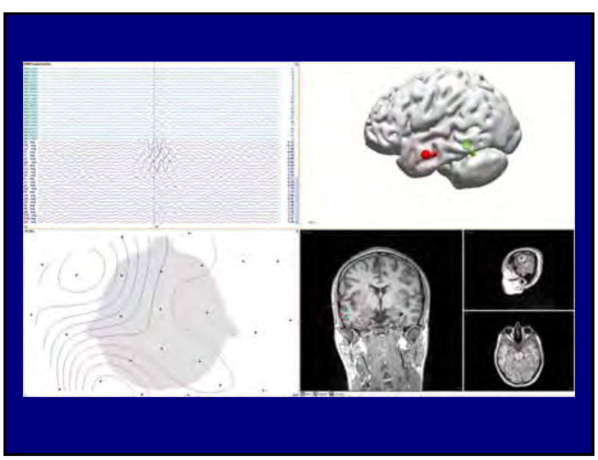


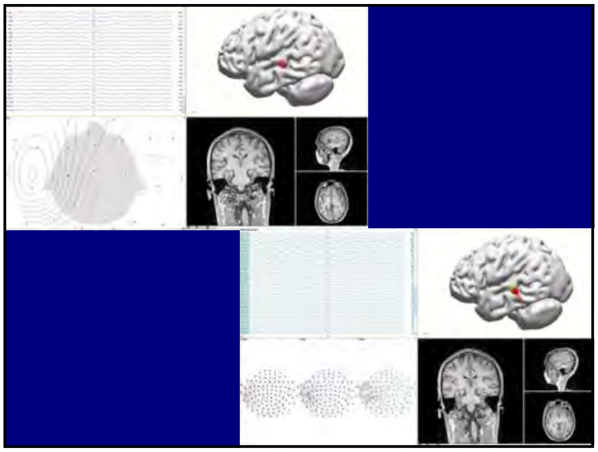






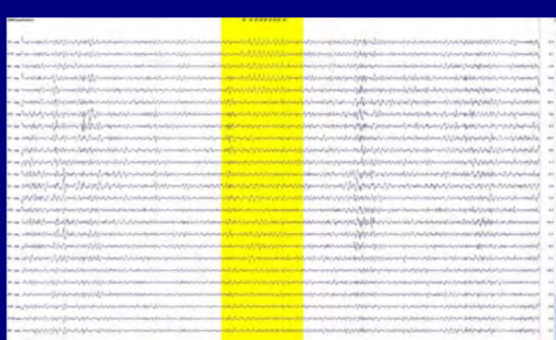


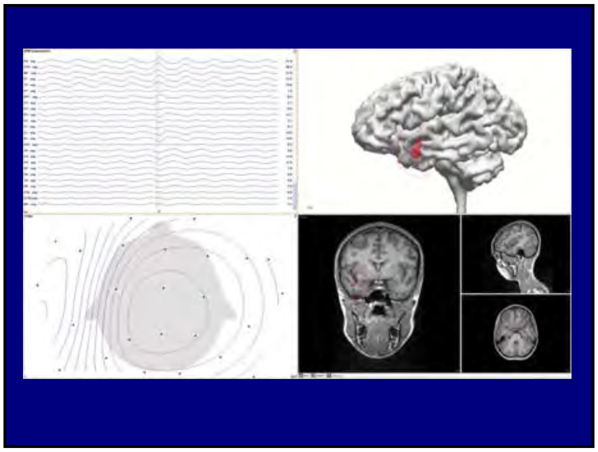


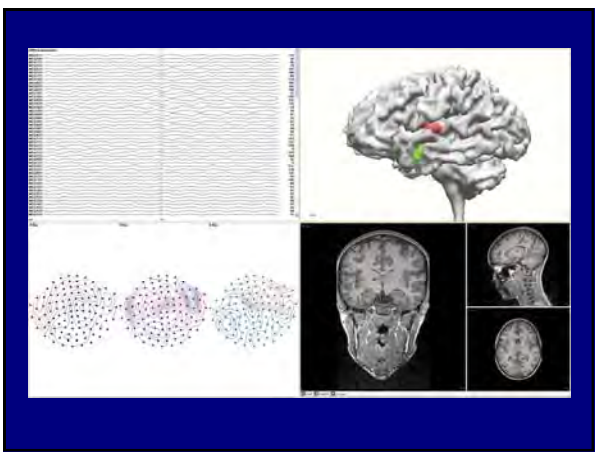


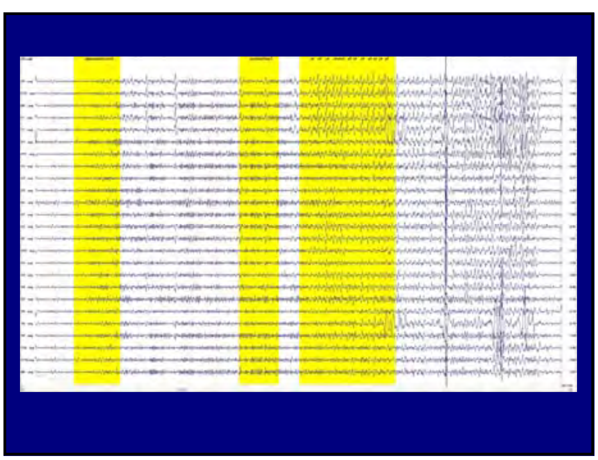
Ictal Interpretation Scenarios

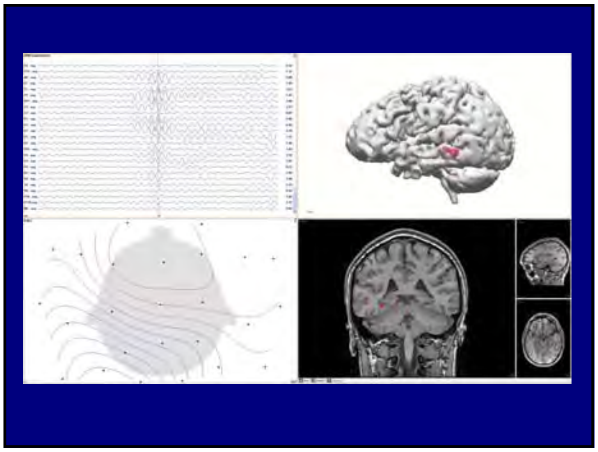
- EEG seizure is better visualized or lateralized than MEG seizure
- EEG shows a better or earlier radial ictal component
- EEG source localization is more accurate

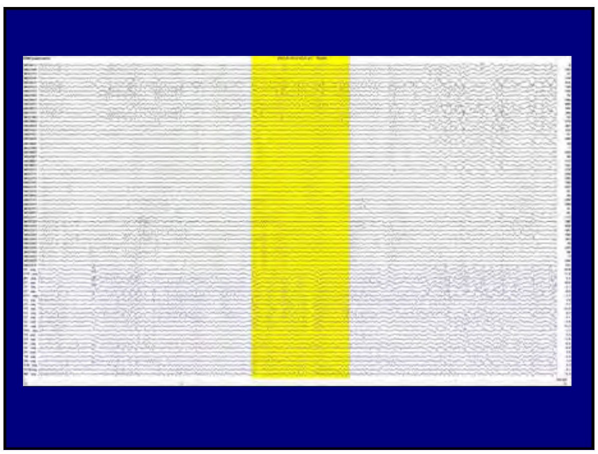


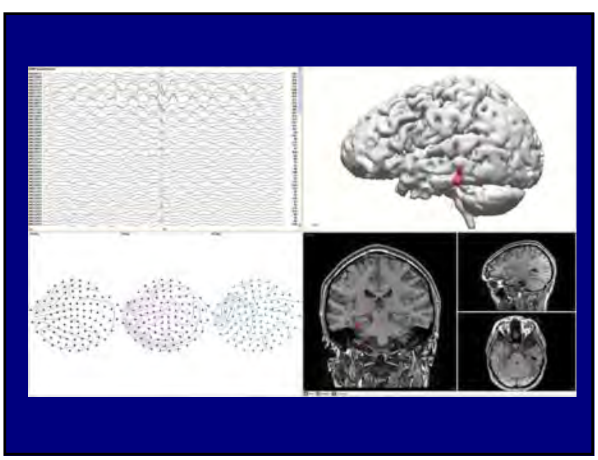


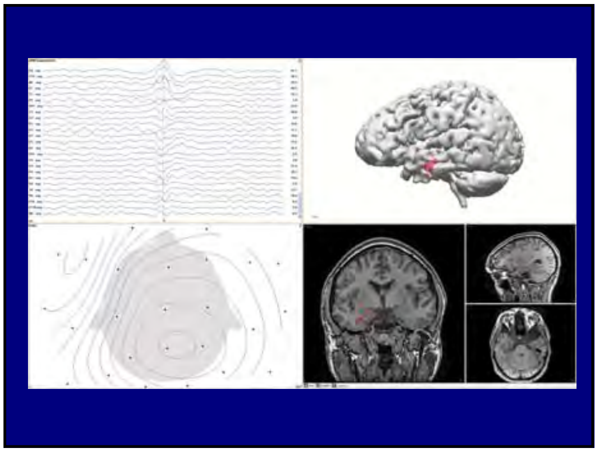


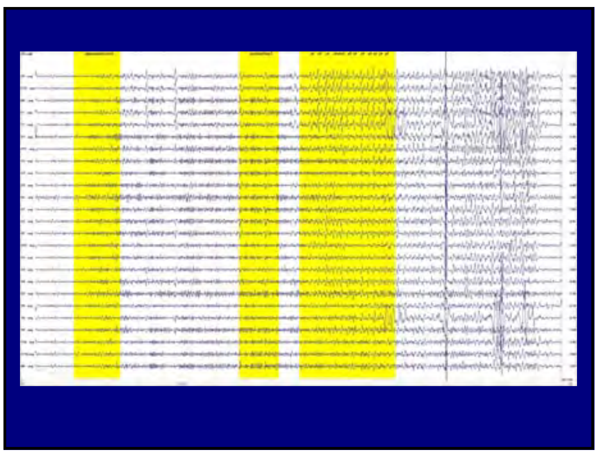


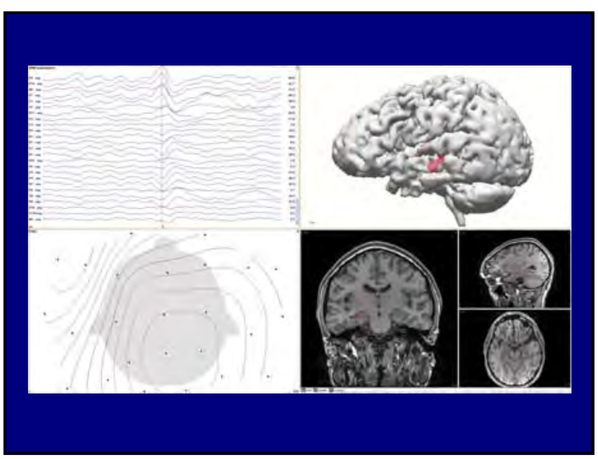


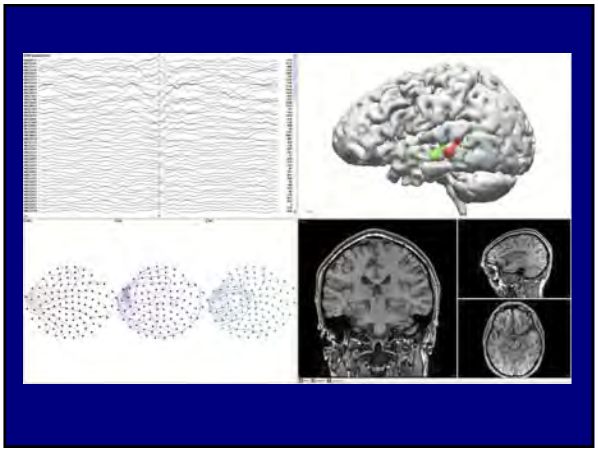


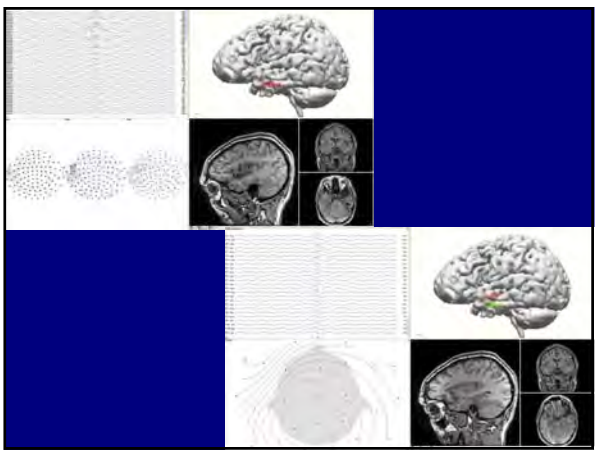






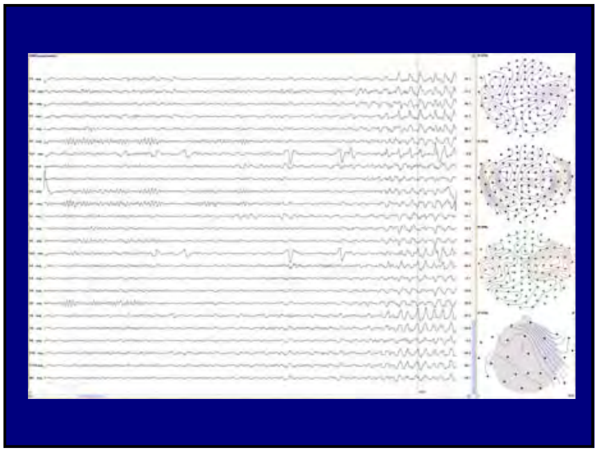


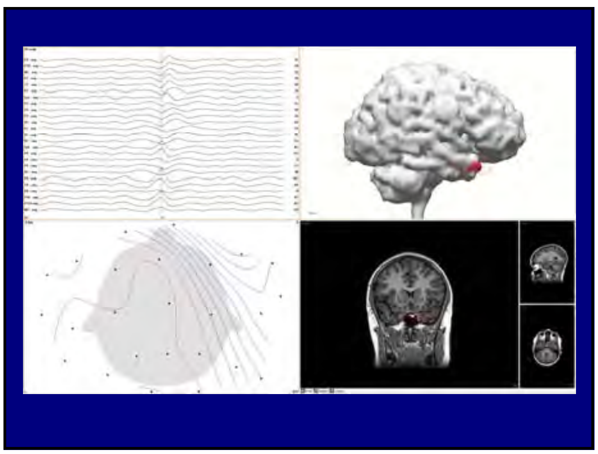


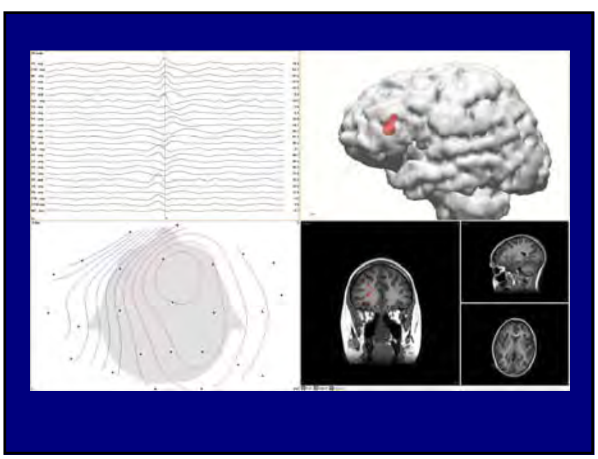


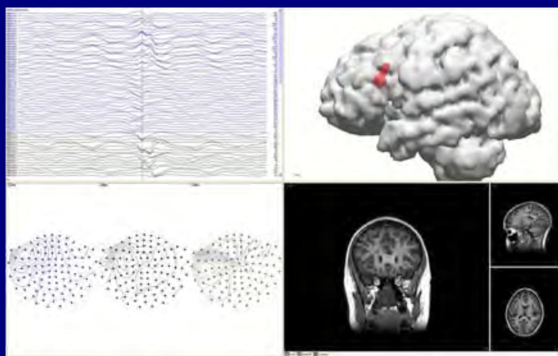
Ictal Interpretation Scenarios

- MEG and EEG source localizations are displaced
- MEG or EEG source localizations are falsely lateralized, secondary to propagation









Conclusions

- MEG and EEG strengths are complementary!
  - MEG: superior source localization and sensitivity
  - EEG: more complete characterization of source orientation and propagation
- Dipole modeling using both MEG and EEG improves the characterization of spike and seizure foci
- Clinical epilepsy evaluations should whenever possible include source models of both data

Workshop: Ictal MEG
Sensitivity and Specificity of Seizure-Onset Zone Estimation
By Ictal Magnetoencephalography

Ritva Paetau, M.D.
Department of Clinical Neurophysiology , Helsinki University Central Hospital
Helsinki, Finland

Ritva Paetau

Sensitivity and specificity of ictal MEG

ACMEGS
Annual meeting February 7, 2013
Ritva Paetau M.D.
Department of Clinical Neurophysiology
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Helsinki University Central Hospital
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BACKGROUND for Ictal MEG:

- Eliashiv et al. 1999:
  - Ictal MEG possible (7/20 patients)
  - à finds seizure onset zone (SOZ) better than interictal MEG (3/7 pats.)
- Shiraisi et al. 2001:
  - Four pats with ictal Frontal lobe sources
- Tiltz et al. 2002:
  - Ictal onset localized in 6/13
  - à correspond to ictal invasive EEG in 4/6.
- Knowlton et al. 2008:
  - 160 prosp. studied epilepsy surgery candidates; 62 pats. MEG vs. IIEEG .
  - à MEG spikes predict IIEEG SOZ at 58-64 % sensitivity and at 79-88 % specificity
- Fujiwara et al 2011:
  - 20 ictal recordings, 8 operated, 7 ictal MEG signals readable.
  - Ictal and inter-ictal MEG sources equal to predict ictal intracranial EEG SOZ at lobar resolution,
  - ictal MEG is better than interictal MEG at sublobar resolution.

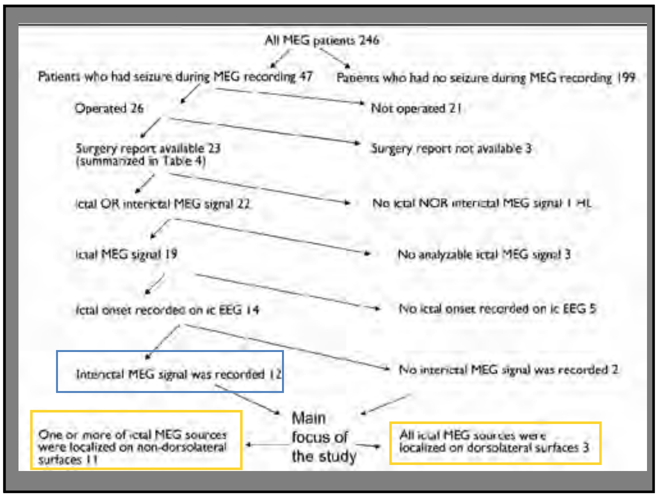
Sensitivity and specificity of seizure –onset zone estimation by ictal magnetoencephalography. Medvedovsky et al. 2012, Epilepsia, Sep;53(9):1649-57

- AIM:
- How well ictal MEG can predict the results on Ictal intracranial EEG?
- How sensitive MEG is to deep brain sources?

- METHODS:
- Elekta Vectorview 306-ch. + 32 or 64 EEG
- 300 or 600 Hz sampling
- Interference removal by signal-space separation (SSS, and/or tSSS)
- Continuous head position monitoring + tSSS enabled accurate data recording despite ictal movement.

Methods

- Elekta Vectorview 306-ch. + 32 or 64 EEG
- 300 or 600 Hz sampling
- Interference removal by signal-space separation (SSS, and/or tSSS)
- Continuous head position monitoring + tSSS enabled accurate data recording despite ictal movement
- Recording time until 1st seizure 1-40 h, mean 5.6 h
- ECD on visually selected inter-ictal and ictal-onset signals
- sphere model of head



Etiology of epilepsy (N=47)

- Focal cortical dysplasia type 2 8
- Focal cortical dysplasia type 1 9
- Tuberous sclerosis 2
- Cavernoma 1
- Traumatic bleeding 1
- Gangliogioma 1
- Local atrophy 2
- Ring chromosome 17 1
- Mesial temporal sclerosis 1
- Unknown 21

Seizure types (patients 23)

• *Focal or bilateral tonic*	*8*
• *Epileptic spasms*	*3*
• *Focal Somato-sensory*	*6*
• *Visual /vertigo*	*2*
• *Psychomotor*	*6*
• *Sensory/visual > Psychomotor*	*2*
• *Hypermotor*	*3*
• *Abdominal > Hypermotor*	*1*
• *Atypical absence*	*1*

Definitions

- *SENSITIVITY =*

$$\frac{\text{TRUE POSITIVES}}{\text{TRUE POSITIVES + FALSE NEGATIVES}}$$

- *SPECIFICITY =*

$$\frac{\text{TRUE NEGATIVES}}{\text{TRUE NEGATIVES + FALSE POSITIVES}}$$

Definitions

- *TRUE POSITIVES =*
  1. *MEG dipoles present in the location*
  2. *IC-EEG electrodes covered the location*
  3. *IC-EEG showed ictal onset in the location*

- *FALSE POSITIVE =*

  1. + 2. as above

  3. IC-EEG did not show ictal onset in the location

Definitions

- *TRUE NEGATIVES =*
  1. No MEG dipoles in the location
  2. IC-EEG did not show ictal onset in the location
- *FALSE NEGATIVE =*
  1. No MEG dipoles in the location
  3. IC-EEG showed ictal onset in the location

Study design

Inclusion criteria

- Seizure onset signal was recorded in MEG (N = 22)
- Seizure onset activity was recorded by intracranial EEG (N =14)

Exclusion criteria

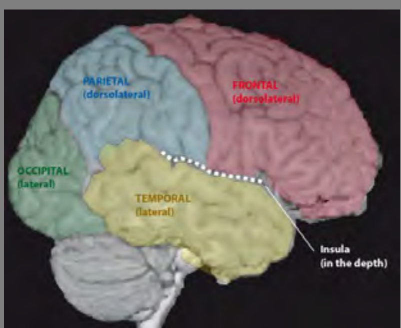
- *Seizure was recorded in MEG, but no ictal signal could be identified (N=3)*

Resolution

Hemisphere-lobe (HL)

- *Frontal,*
- *Temporal*
- *Parietal*
- *Occipital*
- *Insula*

2 x 5 = 10 lobes



Resolution: Hemisphere-Lobe-Surface (HLS); max. 2 x 15 = 30 surfaces

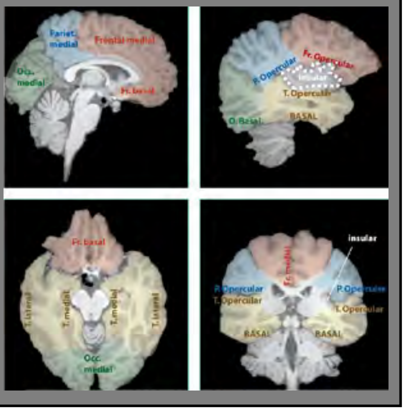
Frontal dorsolateral opercular, basal, medial

Temporal lateral, opercular, basal, medial

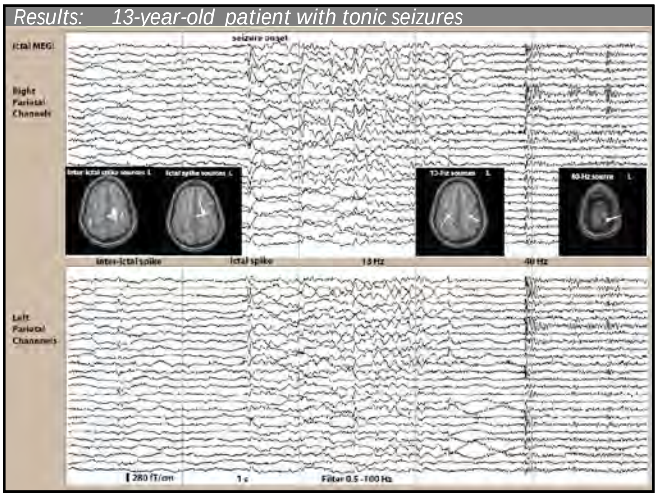
Parietal dorsolateral, opercular, medial

Occipital lateral, medial, basal

Insular



Results: 13-year-old patient with tonic seizures



Results

interictal cluster (MEG C) is less distributed and Ictal MEG is more distributed than the gold std ictal icEEG.

Table 3. Source distribution of ictal and interictal MEG and of icEEG

	Mean	Standard deviation	p-value (vs. ictal MEG)	p-value (vs. ictal icEEG)
HLS				
ii MEG A	6.4	4.7	0.0107	0.0027
ii MEG B	4.9	3.7	0.1005	0.0077
ii MEG C	1.6	0.9	0.0508	0.0663
Ictal MEG	3.6	3.4		0.1260
Ictal icEEG	2.4	1.1	0.1260	
HL				
ii MEG A	3.4	2.3	0.0294	0.0126
ii MEG B	2.9	1.8	0.1039	0.0223
ii MEG C	2.0	1.4	0.5656	0.3986
Ictal MEG	2.4	1.6		0.0211
Ictal icEEG	1.6	0.9	0.0211	

ii, interictal; A, B, and C – conditions A, B and C; icEEG, intracranial EEG.

Table 4. Ictal MEG findings in all 34 HL (lobe) and 60 HLS (surface) locations

	True positive	True negative	False positive	False negative	All
HLS-dorsolateral	13	10	4	6[a]	33
HLS-deep	11	9	3	4	27
HLS-all	24	19	7	10	60
HL	23	9	1[b]	1[b]	34

Deep locations: medial, basal, opercular surfaces and insula.
HLS, hemisphere lobe surface; HL, hemisphere lobe.
[a]Dorsolateral ictal MEG sources were in the sensory-motor cortex near the frontoparietal border in four out of six false negative HLS reports.
[b]Ictal MEG sources were in the sensorimotor cortex near the frontoparietal border in all false positive (one) and false negative (one) HL reports.

Predictive values of ictal MEG. HLS: positive 0.77; negative 0.66
HL: positive 0.96; negative 0.90

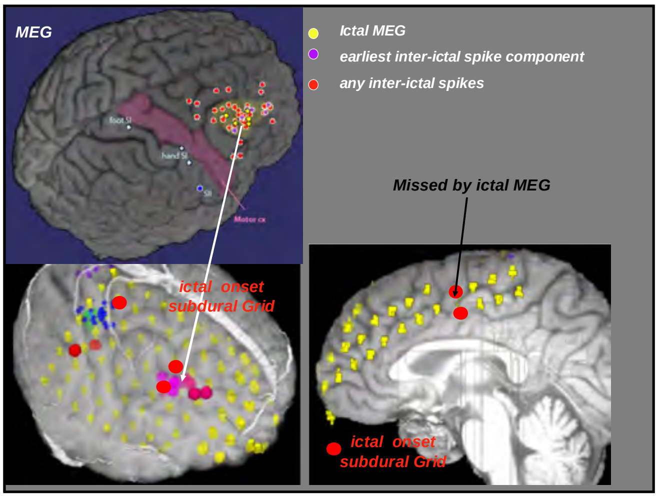


Table 5. Sensitivity and specificity of interictal and ictal MEG source location

	ii-A	ii-B	ii-C	ictal-all	ictal-deep
HLS sensitivity	0.818	0.727	0.400	0.703	0.733
HLS specificity	0.565	0.591	0.769	0.731	0.750
HL sensitivity	0.955	0.955	0.933	0.958	
HL specificity	0.556	0.667	0.750	0.900	

A: at least 1 dipole /location, B: at least 2 dipoles/location, C: at least 10 dipoles/location.
ii, inter-ictal; HLS, surface resolution; HL, lobe resolution.

On Lobe-level, Inter-ictal cluster and Ictal MEG sources were equally sensitive, but ictal sources were more specific.

On surface level,inter-ictal cluster and ictal sources were equally specific, but ictal sources were more sensitive.

DISCUSSION

Because icEEG placement was planned to cover the MEG sources, some false negatives may have been missed, à real sensitivity probably is lower than we calculated

The specificity, sensitivity, and predictive values are similar as reported from other centers using different MEG devices.

The specificity of interictal cluster was high but its sensitivity was low, à Ictal MEG with higher sensitivity would thus complement the interictal MEG

Dorsolateral (superficial) and non-dorsolateral (deep) sources showed similar sensitivities and specificities down to 4 cm below scalp.

CONCLUSIONS

On lobe level, ictal MEG has both a high sensitivity and specificity.

On surface level, Ictal MEG was equally specific but more sensitive than the interctal cluster in predicting the ictal onset zone found by icEEG. à Ictal MEG would thus complement the interictal MEG

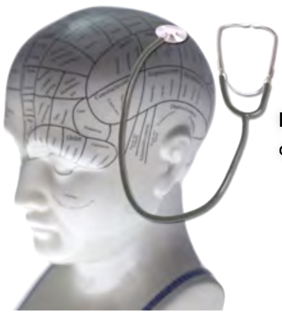
Ictal MEG showed similar sensitivities and specificities for dorsolateral (superficial) and non-dorsolateral (deep) sources until a mean depth of 4 cm below scalp.

Workshop: Clinical MEG

Technical Expert's View: Source Models in Clinical MEG - A Review

Sylvain Baillet, Ph.D.
Montreal Neurological Institute, Montreal, Quebec, Canada

Sylvain Baillet



Perspectives on the Clinical Value of MEG Source Modeling for Epilepsy

Sylvain Baillet

Director, MEG Research
Montreal Neurological Institute
McGill University

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Google ' MEG MNI '

1

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- Medical College of Wisconsin
  Manoj Raghavan, MD, PhD

- Alumni
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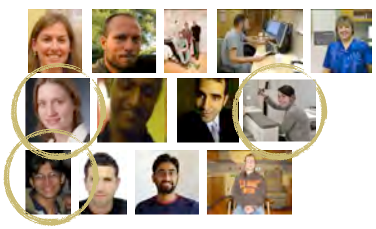
  - Julien Denis, MSc
  - Chiran Doshi, MSc
  - Sheraz Khan, PhD
  - Rey Ramirez, PhD
  - Brenda Terranova
  - Dale Davis



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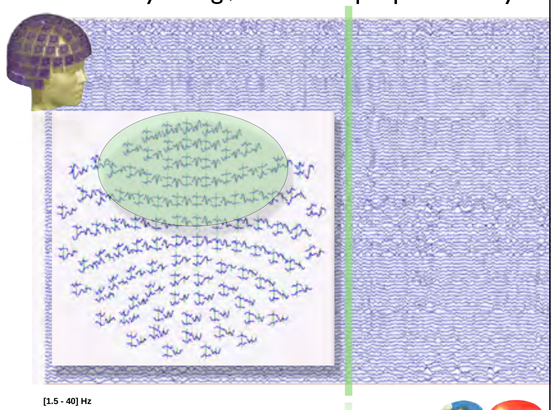
Outline

1) MEG source imaging generates large data volumes
   - Suggest simple, but practical data reduction techniques
2) Review of MEG source imaing outcome is time consuming in a clinical setting
   - Suggest exploratory approaches to reveal new clinical MEG markers of neurological syndromes
3) Imaging is only for diagnosis
   - Suggest MEG can also act as a therapeutic instrument

3

Event-related analysis e.g., interictal epileptic activity



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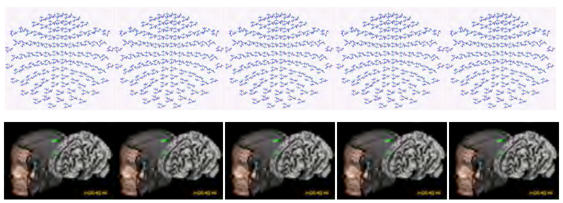
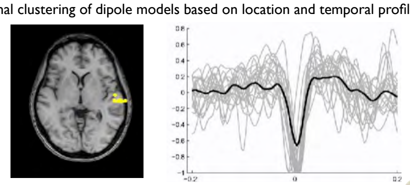
Event #1 Event #2 ...



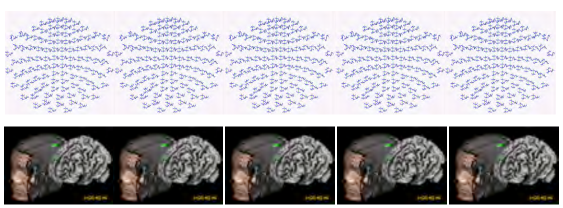
Regional clustering of dipole models based on location and temporal profile



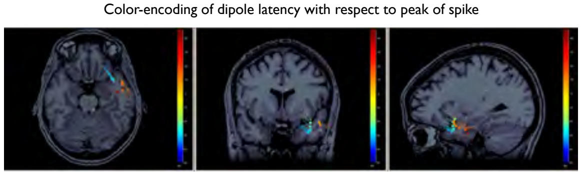
Ossadtchi et al., Clin. Neurophys., 2004

5

Event #1 Event #2 ...

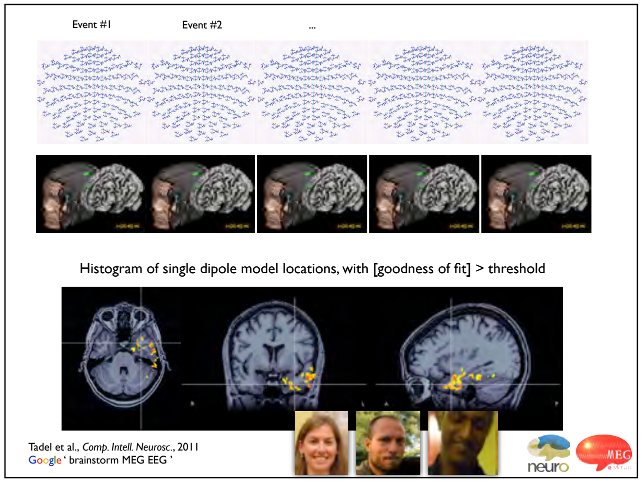


Color-encoding of dipole latency with respect to peak of spike

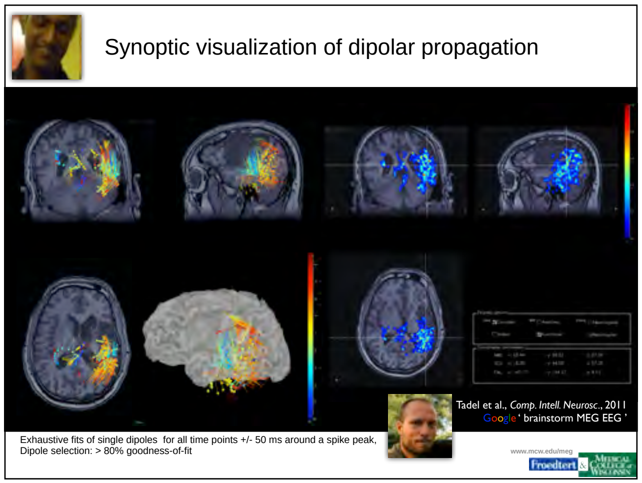


Tadel et al., *Comp. Intell. Neurosc.*, 2011
Google ' brainstorm MEG EEG '

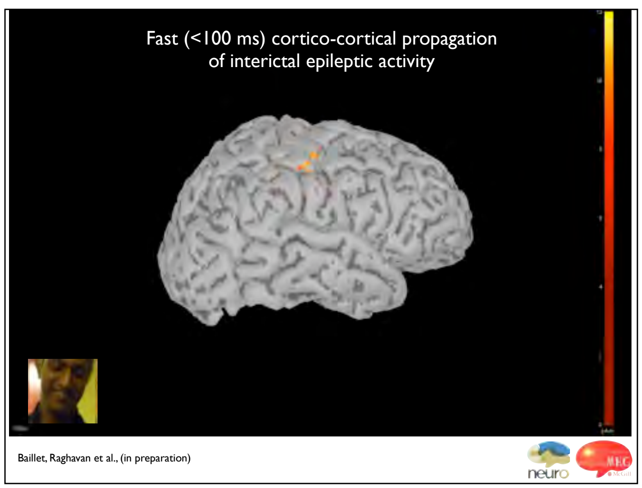
6


Event #1
Event #2
...
Histogram of single dipole model locations, with [goodness of fit] > threshold
Tadel et al., Comp. Intell. Neurosc., 2011
Google ' brainstorm MEG EEG '
neuro
MEG

7

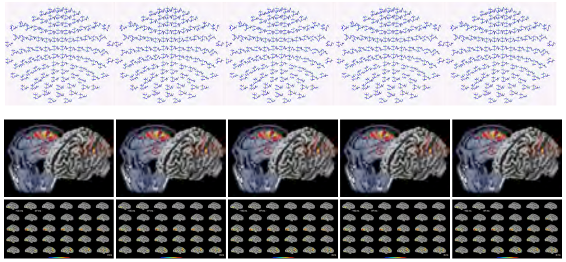

Synoptic visualization of dipolar propagation
Tadel et al., Comp. Intell. Neurosc., 2011
Google ' brainstorm MEG EEG '
Exhaustive fits of single dipoles for all time points +/- 50 ms around a spike peak,
Dipole selection: > 80% goodness-of-fit
www.mcw.edu/meg
Froedtert & Medical College of Wisconsin

8


Fast (<100 ms) cortico-cortical propagation
of interictal epileptic activity
Baillet, Raghavan et al., (in preparation)
neuro
MEG

9

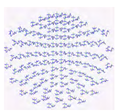
Event #1 Event #2 ...



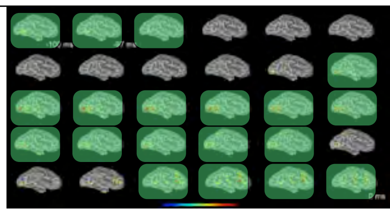
Summary statistics are required for synoptic review of event-related source models

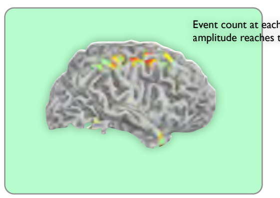
10

Event #1



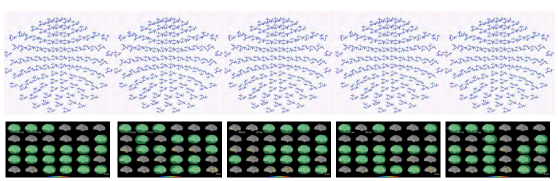
Local amplitude > threshold



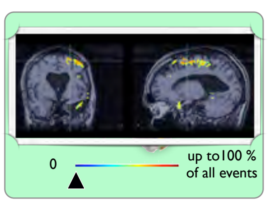


11

Event #1 Event #2 ...

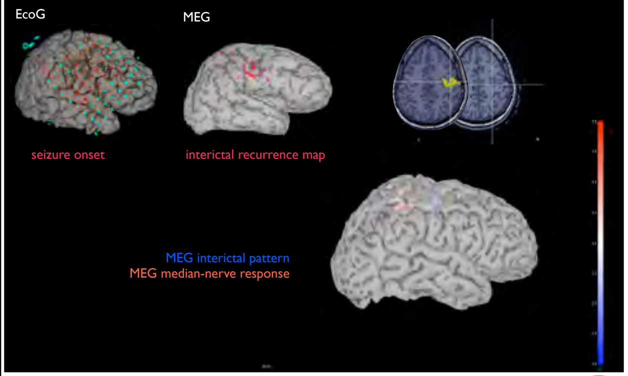


Recurrence map of distributed source activity across a group of interictal events



12

Mapping function & dysfunction



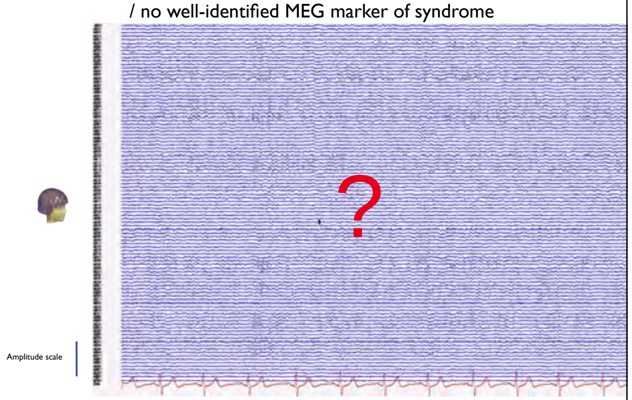
Baillet, Raghavan et al., (in preparation)

13

Exploratory approaches for new clinical MEG markers

14

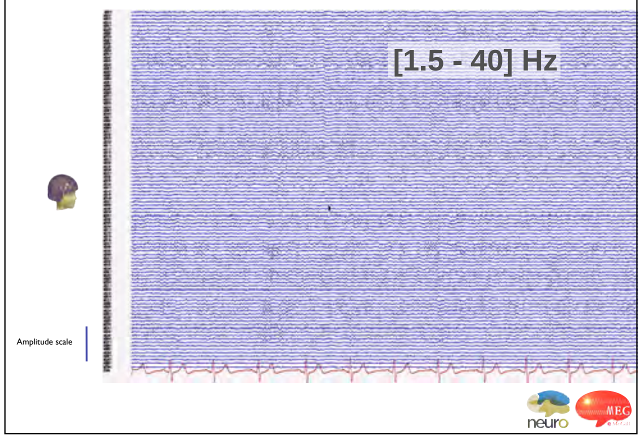
Most likely scenario: no or few eloquent epileptic events / no well-identified MEG marker of syndrome



[1.5 - 40] Hz

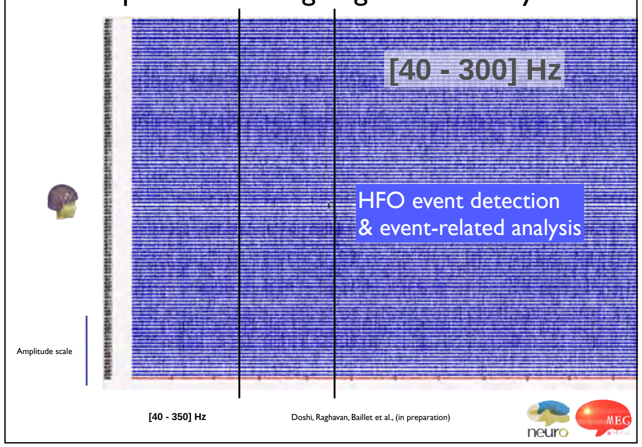
15

Spectrum of ongoing brain activity



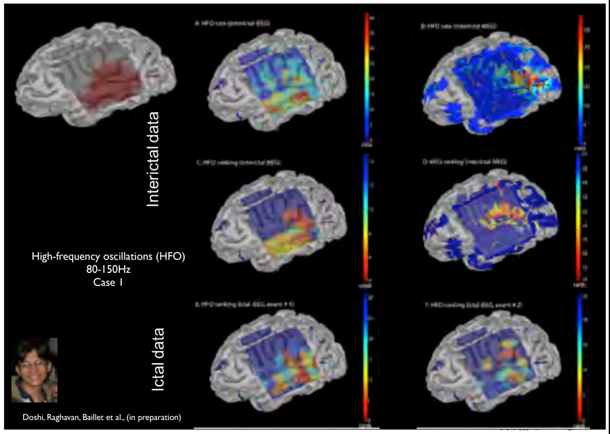
16

Spectrum of ongoing brain activity



17

Event-related MEG detection and imaging of HFO generators



18

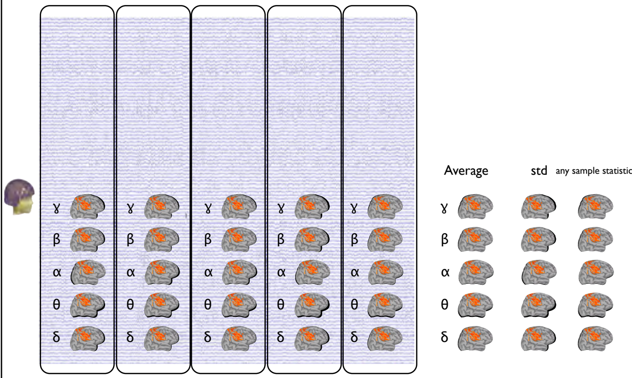
Clinical specificity of HFO's?

Need to establish new standards
for epilepotgenic brain dysrythmias

Empirical data mining and databasing

19

Tracking of power dynamics in ongoing brain signals



Baillet, Raghavan et al., (in preparation)

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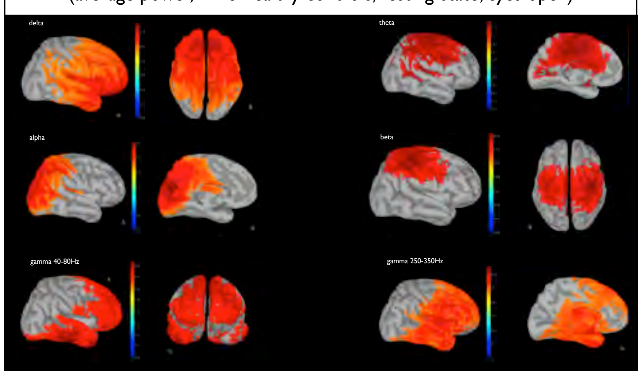
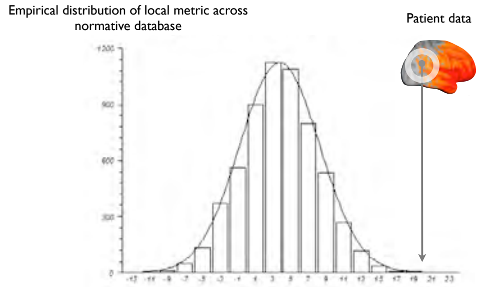
Normative distribution of ongoing brain rhythms
(average power, *n*=45 healthy controls, resting-state, eyes open)



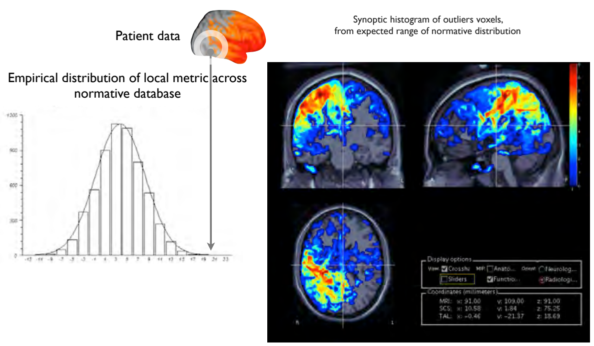
Baillet, Raghavan et al., (in preparation)

21

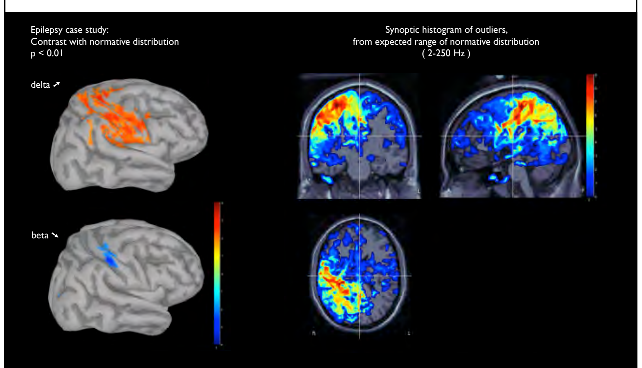
Assessing the likelihood of individual data as normal variant



Assessing the likelihood of individual data as normal variant



Local deviants from normative ongoing brain activity: interictal epilepsy



Baillet, Raghavan, et al., (in preparation)

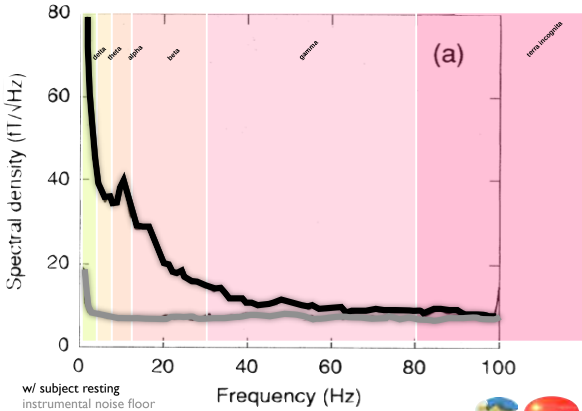
Markers of epilepsy:

Is there more than magnitude effects
of local/regional/global brain dysrhythmia?

First non-invasive evidence of localized disrupted
cross-frequency coupling in partial epilepsy

25

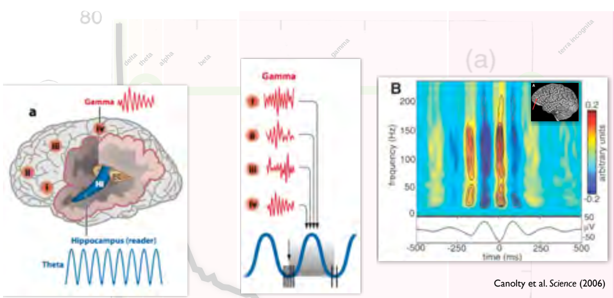
The resting brain: frequency power spectrum



adapted from Hamalainen et al. *Rev. Mod. Phys.* (1993)

26

Cross-frequency phase-amplitude coupling:
A generic mechanism for local and long-range brain dynamics?



Buszaki & Wang
Ann Rev Neurosc (2012)

Canolty et al. *Science* (2006)

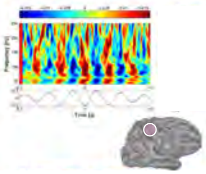
Can MEG help?
Is it pertinent for epilepsy evaluation, other neuropathologies?

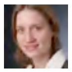
27

First non-invasive evidence of
local phase-amplitude coupling (PAC) between neural rhythms in the resting-state

- Low-frequency 'nesting': [2, 12] Hz
- Phase-locked high-frequency bursts: [35, 250] Hz

- 2 subjects
- 10-min MEG session





Florin & Baillet (submitted)

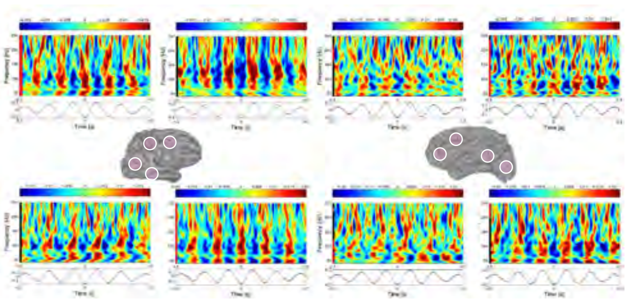
-> Esther Florin's talk @ S-Th-A1 Resting-state symposium

28

First non-invasive evidence of
local phase-amplitude coupling (PAC) between neural rhythms in the resting-state

- Low-frequency 'nesting': 4.7Hz Hz
- Phase-locked high-frequency bursts: [35, 250] Hz

- 2 subjects
- 10-min MEG session

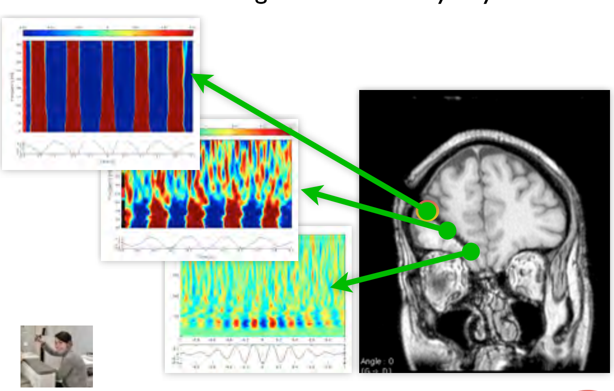


Florin & Baillet (submitted)

-> Esther Florin's talk @ S-Th-A1 Resting-state symposium

29

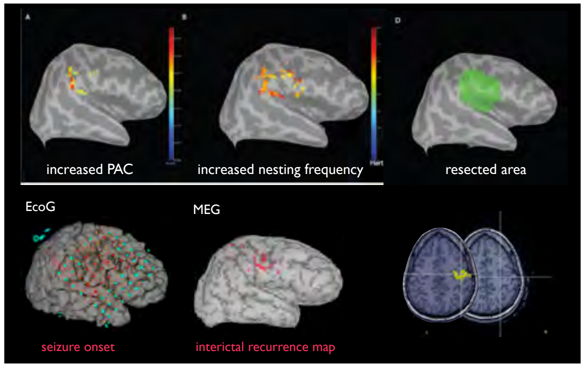
Intracranial investigations of PAC dysrhythmia



Luneau, Dubeau, Raghavan et al., (in preparation)

30

MEG investigations of PAC dysrhythmia



Luneau, Dubeau, Raghavan et al., (in preparation)

31

MEG as a therapeutic instrument

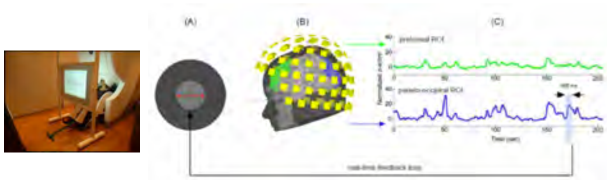
Targeted modulation of ongoing brain activity

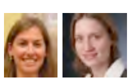
Real-time neuroimaging with feedback to subject

"neurofeedback"

32

Concept





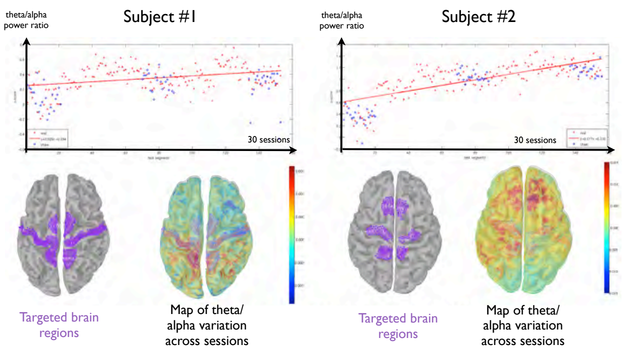
(Sudre, Parkkonen, Bock, Baillet et al., *Comp. Intell. Neurosc*, 2011)
(Bock et al., *Int. Conf. for Human Brain Mapping*, 2011)

33

Real-time neuroimaging with feedback to subject

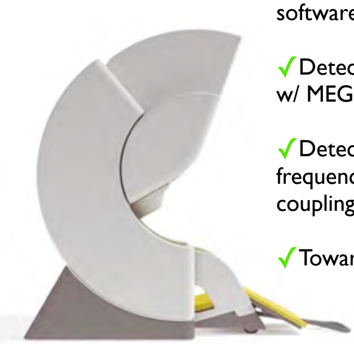
34

Targeted training of regional brain activity



(Bock, Florin et al., in preparation)

35



- ✓Efficient data mining with simple representations & efficient software
- ✓Detection of interictal HFOs w/ MEG; colocalized w/ ECoG
- ✓Detection of normal cross-frequency phase-amplitude coupling w/ MEG
- ✓Towards MEG therapy?

Thank you.

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Workshop: Clinical MEG

Clinician's View: Role of MSI in Pediatric Epilepsy

Gretchen Von Allmen, M.D.
University of Texas, Houston, TX

Gretchen Von Allmen

Notes

Workshop: Clinical MEG

Clinical Researcher's View: Genuine Benefits of MEG in Epilepsy

Robert Knowlton, M.D.
University of Texas, Houston, TX

Genuine Benefits of MEG in Epilepsy

Robert Knowlton, MD, MSPH

UTHealth The University of Texas Health Science Center at Houston

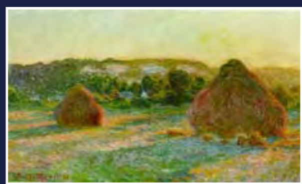
Epilepsy Surgery and Imaging

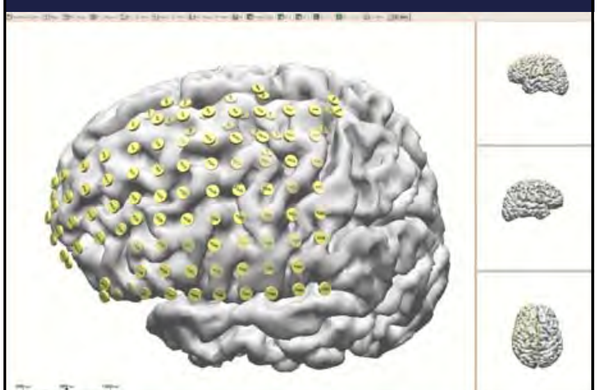
I. History of epilepsy imaging
II. Role of epilepsy imaging: Mesial temporal versus neocortical epilepsy surgery
III. Clinical validity and *diagnostic value* of epilepsy imaging tests
IV. Decision analysis

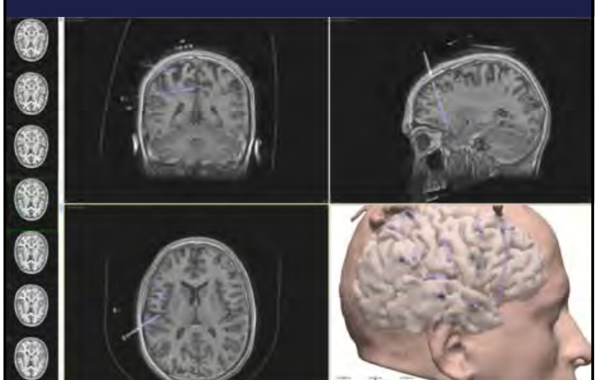
Clinical value of Functional Imaging in Epilepsy Surgery

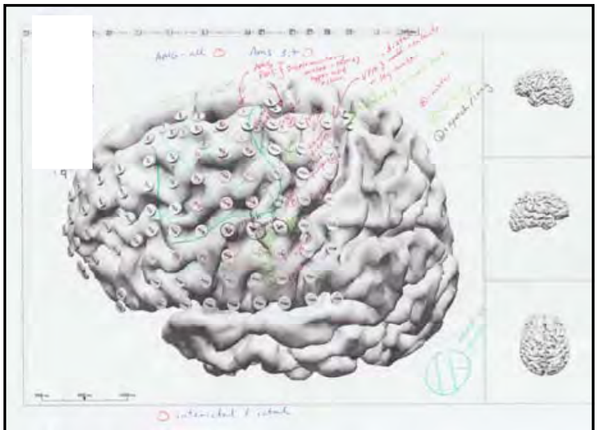
- Epilepsy surgery clinical context–stakes are uniquely high (effect size is very large)
- Impact of a test (MSI) must account for and distinguish between two important effects:
  1. Diagnostic value on patient selection
     - Go –no go further in surgical evaluation
     - Who should and should have surgery
  2. Effect on cure rate
- Trials, decision analysis and cost effectiveness

The Problem

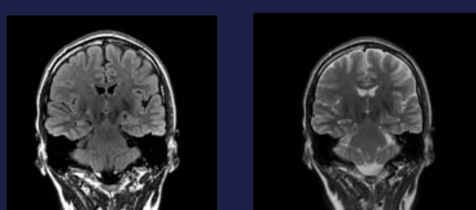






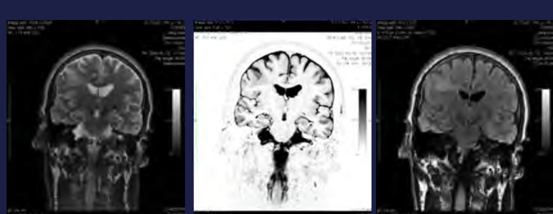


Impact of Imaging: MRI detection of hippocampal sclerosis

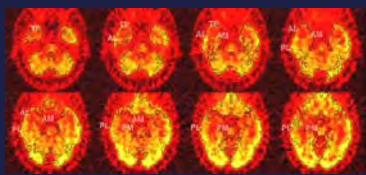


Berkovic et al., 1991; Jackson et al., 1990

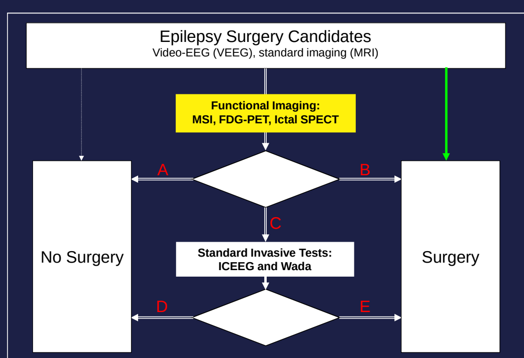
Impact of Imaging: Detection of epileptogenic lesions



Impact of Imaging: FDG-PET detection relative hypometabolism

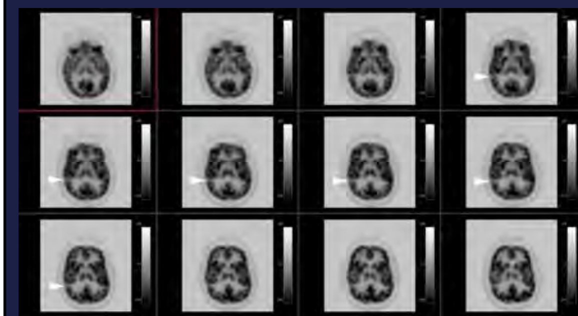


Abou et al., 1987; Engel, 1984; Mazziotta, 1984; Shimizu et al., 1985; Sperling et al., 1986; Stefan et al., 1987; Theodore et al., 1986

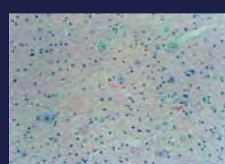


Functional Imaging and Epilepsy

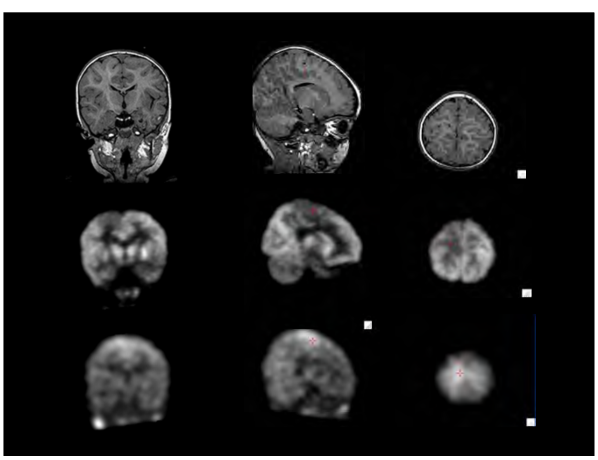
1. Localization of epileptogenic tissue
2. Determining the functional significance (epilepsy relationship) of other imaging abnormalities that cannot stand alone
3. Mapping of brain function

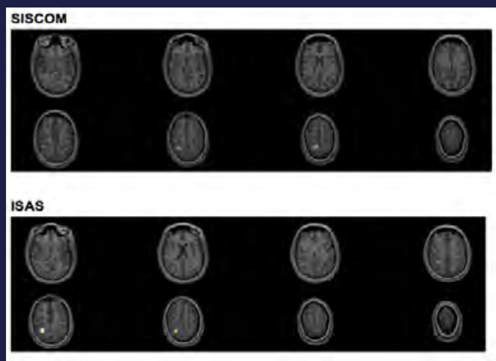


Epilepsy relationship / significance

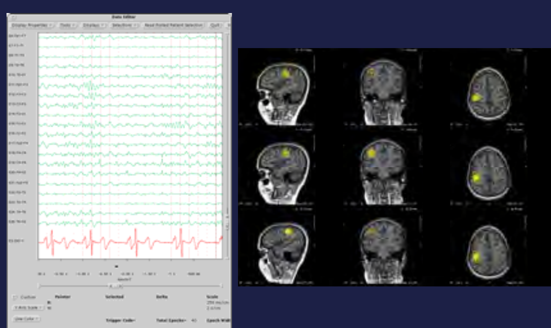


Focal Cortical Dysplasia with Taylor Type II Balloon Cells

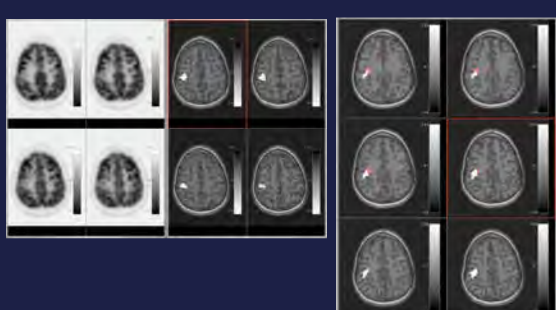




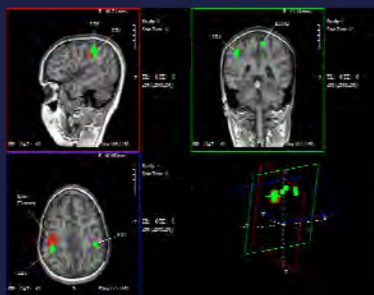
EEG/MEG: Source Localization



Concordance: PET-MSI-iSPECT



Brain function mapping



JAMA

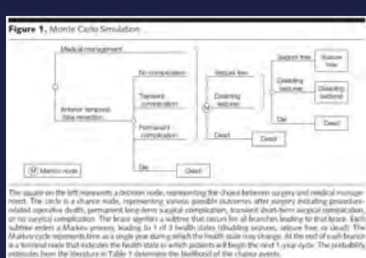
Online article and related content current as of December 2, 2008.

Epilepsy Surgery for Pharmacoresistant Temporal Lobe Epilepsy: A Decision Analysis

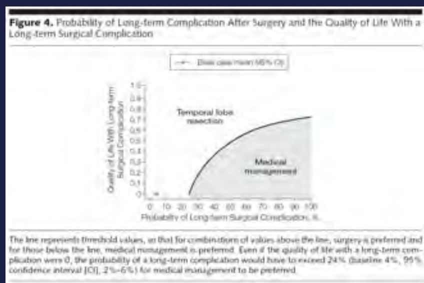
Hyunmi Choi, Randall L. Sell, Leslie Lenert; et al.

JAMA. 2008;300(21):2497-2505 (doi:10.1001/jama.2008.771)

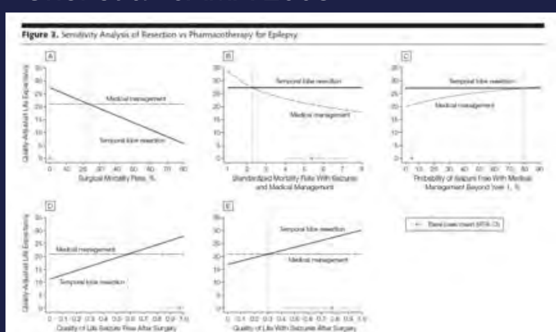
MTLE Surgery Decision Analysis



Impact of Epilepsy Surgery: Choi et al. JAMA 2008



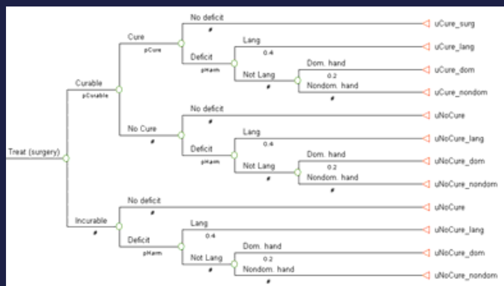
Impact of Epilepsy Surgery: Choi et al. JAMA 2008



MEG Populations of Interest?

1. Temporal lobe–MRI negative
2. Neocortical epilepsy
3. Lesional epilepsy (uncertain functional significance; ambiguous or multiple abnormalities on MRI)

Decision Tree: NE Surgery



Surgical outcome: UAB subdural grid based neocortical epilepsy resections

	MRI (-)	MRI (+)
	n=35	*n*=39
Mean age of onset (Range)	10 (1-33)	8 (1-23)
Mean age (Range)	24 (1-52)	24 (1-52)
Gender, M:F	16:19	25:15
Mean duration of epilepsy (Range)	16 (1-48)	17 (1-49)
Mean duration of follow up (Range)	4.0 (1.3-10.5)	5.5 (1.1-13.8)
VEEG Classification, n		
Extratemporal	29	32
Lateral Temporal	6	4
Non-Localized	0	3
Surgical Outcomes, n (%)		
Free of Disabling Seizures	20 (57)	20 (54)
Rare Disabling Seizures	7 (20)	9 (22)
Worthwhile Improvement	4 (11)	5 (14)
No Worthwhile Improvement	4 (11)	5 (10)

NE surgery outcomes

The findings are consistent with the average published seizure-free surgical outcome for neocortical epilepsy (~50%)†

MRI (-)	MRI (+)	Total
204/463 (44%)	143/250 (57%)	347/713 (49%)

† Based on 13 published studies in which distinction between MRI class could be determined.

Preference-Based Quality of Life Scores for Model Health States[a]		
Free of disabling seizures		
Medical management	0.96 (0.84-1.0)	Uniform
Surgery		
No surgical complication	0.97 (0.87-1.0)	Uniform
Permanent complication	0.77 (0.32-1.0)	Uniform
Transient complication	0.96 (0.84-1.0)	Uniform
Not free of disabling seizures		
Medical management	0.75 (0.38 to 1.0)	Uniform
Surgery		
No surgical complication	0.78 (0.41 to 1.0)	Uniform
Permanent complication	0.66 (0.19 to 1.0)	Uniform
Transient complication	0.75 (0.38 to 1.0)	Uniform
Transient surgical complication (days of life deducted)	1.5 (0 to 25.0)	Uniform

Choi et al. JAMA. 2008; 300: 2497-2505

Preference-Based Quality of Life Scores for Model Health States

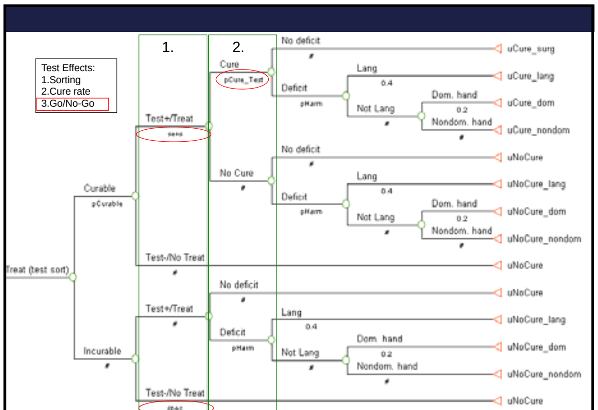
	Probability mean	(95% Confidence Interval)
Free of disabling seizures		
Medical management[a]	0.89	(0.82, 0.96)
Surgery[b]		
No complication	0.98	(0.97,1.00)
Language deficit	0.83	(0.76, 0.90)
Dominant hand sensory/motor loss	0.88	(0.82, 0.93)
Non dominant hand sensory/motor loss	0.93	(0.91, 0.96)
Not free of disabling seizures		
Medical management	0.78	(0.70, 0.86)
Surgery		
No complication	0.78	(0.70, 0.87)
Language deficit	0.71	(0.62, 0.80)
Dominant hand sensory/motor loss	0.77	(0.70, 0.84)
Non dominant hand sensory/motor loss	0.81	(0.74, 0.88)

[a] Medical management maintained on two or more antiepileptic medications.
[b] Postsurgical management maintained on only one antiepileptic medication.

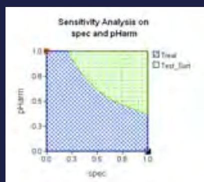
Knowlton et al. Epilepsia. 2011; 52: 1018-1020

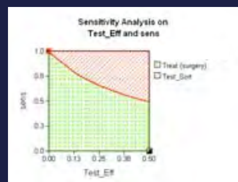
Inserting Test Effect into Analysis

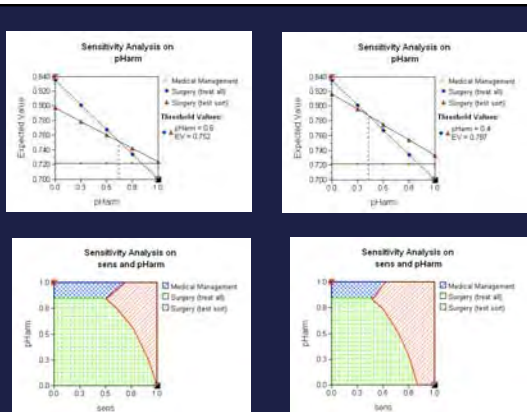
Test Effect	Clinical Value
Diagnostic	Patient selection
Treatment	Improve outcome
Additive	Increase proportion of “go” cases
Risk assessment	Reduce morbidity
Economic	Reduce net costs



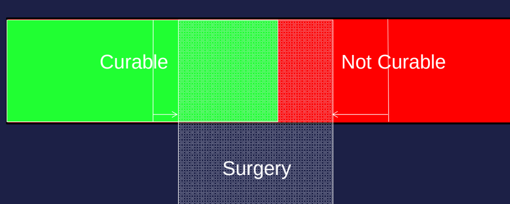
Test Effects on NE Decision Analysis



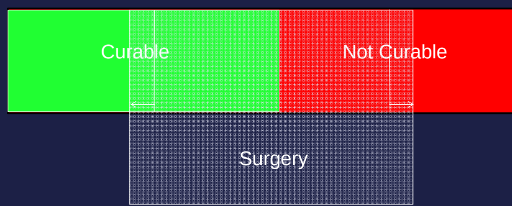




Effecting Outcomes vs Discrimination



Effecting Outcomes: Increasing availability only



Impact of Epilepsy Surgery: Cost Effectiveness in Test Utility

The Cost-Effective Use of ^{18}F-FDG PET in the Presurgical Evaluation of Medically Refractory Focal Epilepsy

Terence J. O'Brien[1], Ken Miles[2], Robert Ware[3], Mark J. Cook[4], David S. Binns[3], and Rodney J. Hicks[3]

[1]Departments of Medicine, Surgery, and Neurology, Royal Melbourne Hospital, University of Melbourne, Parkville, Victoria, Australia; [2]Brighton and Sussex Medical School, University of Sussex, Brighton, United Kingdom; [3]Centre for Molecular Imaging, Peter MacCallum Cancer Institute, Victoria, Australia; and [4]Centre for Clinical Neuroscience and Neurological Research, St. Vincent's Hospital, Melbourne, Australia

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Cost Effectiveness in Test Utility

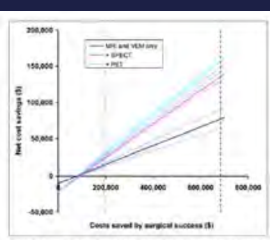

FIGURE 1. Plot of cost savings (over medical treatment only) for 3 imaging strategies (VEM/MRI, + SPECT, + PET) with confidence limits determined from sensitivity analysis (dotted lines). Vertical dashed lines indicate reported upper and lower values for cost savings produced by successful epilepsy surgery.

O'Brien et al. The Journal of Nuclear Medicine • Vol. 49 • No. 6 • June 2008

MEG Value in NE Surgery

1) Patient selection (?)
2) Improving ICEEG localization yield and accuracy – – –> increase cure rate
3) Aiding other tests such that an increased proportion of patients may proceed to surgery
4) Decrease costs

What is needed to show test clinical value?

1) Test must effect an improvement in *net seizure-free* outcome (around 10-15%).
2) If test cannot sufficiently effect the total cure rate, then it must be demonstrated to allow more patients to receive surgery (with or without effect on outcome).

Acknowledgements

Update on Educational Initiatives
Update on Clinical MEG Fellowship

Richard C. Burgess, M.D.
Cleveland Clinical Epilepsy Center, Cleveland, OH

Richard Burgess

Notes

Update on Educational Initiatives

Update on MEG/EEG Technologist Survey

Judy Ahn-Ewing R EEG EP/T, ASET President
Janice Walbert R EEG T, ABRET Executive Director

Judy Ahn-Ewing & Janice Walbert

ABRET/ASET ACMEGS Presentation

Judy Ahn-Ewing, R. EEG/EP T, CNIM, CLTM, FASET
ASET President

Janice Walbert, R. EEG/EP T.
ABRET Executive Director

Collaboration History

- Dec 2011
  - ACMEGS, ABRET, ACNS, and ASET reps meet in Baltimore during the AES conference

Collaboration History

- Feb 2012
  - ASET creates MEG Interest Section
    - Co-leaders: Hisako Fujiwara, R. EEG/EP T., CLTM, RPSGT and JP Lowe, R. EEG/EP T., CNIM, CLTM
  - MEG forum added to the discussion forums on the ASET website

Collaboration History

- ASET 2012 Annual Conference in St. Paul, MN
  - Platform Presentation: MEG in the Evaluation of Post-Resection Seizure Occurrence by Susan Ebersole, R. EEG T.
  - Sundown Seminar: MEG Workshop by John Ebersole, M.D. and Susan Ebersole, R. EEG T.

Collaboration History

- ASET Webinars
  - April 2008 Magnetoencephalography by Susan Bowyer, Ph.D.
  - Sept 2009 Comparison of MEG Source Localization Techniques by Susan Bowyer, Ph.D.

Collaboration History

- Fall/Winter 2012
  - MEG Personnel Survey developed by ACMEGS, ABRET, and ASET
- January 10, 2013
  - MEG Personnel Survey sent to 35 MEG technologists
- January 30, 2013
  - last day to respond to the survey

What about credentialing or certification?

- Certification – Complete required curriculum and take a certification examination.
- Credentialing – Meet set eligibility requirements to be accepted for examination.

Pathway

- Education First
- Competency Assessment Second

To develop an exam…

- **Establish** eligibility
- **Identify** subject matter experts
- **Perform** Task Delineation or Job Analysis
- **Set** examination specifications
- **Develop** an item bank (writing and reviewing)
- **Review** the examination
- **Administer**

Subject Matter Experts are key

- Item writers
- Item reviewers
- Exam reviewers

ABRET has a 50 year history of credentialing technologists in neurodiagnostics

How can ABRET help?

- Planning
- Development
- Testing
- Psychometrics
- Credential Management

ACMEGS Annual Lecture

Simultaneous MEG and Intracranial EEG Recordings:

What Have We Learned?

Andreas Alexopoulos, M.D.
Cleveland Clinic, Cleveland, OH

Andreas Alexopoulos

Notes

AKNOWLEDGMENT

Grateful acknowledgment is made to the following organizations for their generous support of this workshop in the form of unrestricted educational grants.

ELEKTA

AMERICAN CLINICAL MAGNETOENCEPHALOGRAPHY SOCIETY
2013 Annual Conference ♦ February 7, 2013

Evaluation Form

Please identify yourself: ☐ Neurologist ☐ Neurosurgeon

☐ Radiologist ☐ MEG/EEG Technologist

☐ Other ______________________________________

Please rate each speaker's effectiveness in conveying the material of his/her presentation using 5 as most effective and 1 as least effective:

	Most Effective			Least Effective		
Faculty						**Comments**
Dr. Bagic	5	4	3	2	1	
Dr. Paetau	5	4	3	2	1	
Dr. Ebersole	5	4	3	2	1	
Dr. Baillet	5	4	3	2	1	
Dr. Von Allmen	5	4	3	2	1	
Dr. Knowlton	5	4	3	2	1	
Dr. Burgess	5	4	3	2	1	
Ms. Ahn-Ewing	5	4	3	2	1	
Ms. Walbert						
Dr. Alexopoulos	5	4	3	2	1	

Please rate using 5 as most effective and 1 as least effective:

Rate your overall satisfaction with the opportunity to network with colleagues.	5	4	3	2	1
Rate your overall satisfaction with the quality of this conference/workshop.	5	4	3	2	1
Please rate your satisfaction with the organization of the conference/workshop.	5	4	3	2	1
How would you rate the cost of registration versus what you personally got out of the conference?	5	4	3	2	1

What topics should be addressed at future meetings?

____

____

What features should be added to future meetings?

____

____

What features should be deleted from future meetings?

____

____

Did you perceive commercial bias in any of the presentations? ☐ Yes ☐ No

Explain: ____

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