Gamma Knife in Treatment of Primary & Secondary Intracranial Tumors; Functional Disorders & Vascular Malformations
November 7, 2013

Disclosure Information:
Dr. Chen and Dr. Kee have disclosed they have no relevant financial relationships with commercial interests that may have a direct bearing on the subject matter of this CME activity.

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Welcome
Tony Melaragno, M.D., CEO
Legacy Cancer Institute
Gamma Knife in Treatment of Primary & Secondary Intracranial Tumors; Functional Disorders & Vascular Malformations

Agenda:

- **Leksell Gamma Knife® Perfexion™: Technology Overview**
  - Bruce Proctor, Stereotactic Sales Manager West, Elekta Inc.
- **Gamma Knife Radiotherapy after Metastatic Tumor Resection**
  - Jefferson Chen, M.D.
- **Gamma Knife Stereotactic Radiosurgery**
  - Andrew Kee, M.D.
- **Question & Answer Session**
A Presentation to Legacy Health

LEKSELL Gamma Knife® PERFEXION™

By

Bruce E Proctor
Leksell Gamma Knife® and SRS Sales Manager
Western United States and Mexico

May 26, 2011
In 2002 we formed a group within Leksell Gamma Knife Society consisting of neurosurgeons, radiation oncologists and medical physicists.

We asked this group the simple, yet complex question: **What is the ultimate tool for Gamma Knife surgery?**
Background

This is what they said:

Create a system with:

- Best dosimetry performance
- Best radiation protection for patient and staff
- Unlimited cranial reachable volume
- Full automation and one-push button approach
- Outstanding patient and staff comfort
And after five years of research and development …this is the result

**Leksell Gamma Knife® PERFEXION™**

- A new and revolutionary platform for radiosurgery in the brain
- A technological breakthrough that will improve and expand Gamma Knife surgery
- Full clinical compatibility with Gamma Knife procedures & protocols based on 400,000 treated patients
Leksell Gamma Knife® PERFEXION™
And this is PERFEXION…
Treatable volume

Leksell Gamma Knife C

Leksell Gamma Knife PERFEXION
Unlimited cranial reach

• Increased treatable volume by more than 300%

• Cerebral cases
  ~ 10% increase in available number of patients for existing indications due to extended reachability

• Head & neck
  ~ 10% additional patients from lesions in paranasal sinuses, glomus tumors, orbits and some upper cervical lesions
Target focus access

Leksell Gamma Knife C

Leksell Gamma Knife PERFEXION
Leksell Gamma Knife is already known for its remarkable ease-of-use and efficiency.

With PERFEXION, we decided to take this one step further
Optimized workflow

**Saving time:**

- 1 hour / patient compared with Leksell Gamma Knife U/B
- 30 minutes / patient compared with Leksell Gamma Knife C/4C
- A real case study showed 1 hour for a 15 metastatic lesions patient
- Complete procedure implemented via one push button operation

* Automation and workflow save 3-5 working weeks of physician time per year*

* For a site with 200 patients per year
Outstanding dosimetry
Collimator system 0-0-0-0-0-0-0-0-0
Collimator system 4-4-4-4-4-4-4-4
Collimator system 8-8-8-8-8-8-8-8
Collimator system 16-16-16-16-16-16-16-16-16
Collimator system 8-16-16-16-16-16-16-16
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Collimator system 8-16-8-16-8-16-16-16
Collimator system 8-16-8-16-8-16-8-16
Outstanding dosimetry

• Dose performance
  – Patented collimator design provides almost unlimited ability for sculpturing the dose distribution
  – Optimized design guarantees full backwards compatibility to existing Gamma Knife surgery protocols and methods

• Shot features enabled
  – Classic
  – Composite
  – Dynamic shaping

• Inverse planning
• Convolution algorithm in Leksell GammaPlan®
Composite shot
Dynamic shaping
Leksell GammaPlan® PFX™

- PC based treatment planning system with client-server architecture
- Remote planning capability
- Scalable database to terabyte size
- Instant access to all patient data
- Multi-user access
- Share data with other colleagues/sites

Freedom to plan - unleash the power of PERFEXION
GammaPlan PFX - a client server solution
When design meets performance and function
Robust, oversized - built to last
Reliability and serviceability in focus

- State of the art industrial components
- The best solutions from tooling and machining applications
- Extensive long life testing and life-time calculations performed
- Serviceability via computerized diagnostic tools
- Modularization and standardized components ensures the highest uptime
Best radiation protection for patient

- Body doses up to 100 times less than from alternative technology
- Leakage levels low enough to allow for a window into the operating room
- Room design can be optimized to space and cost
Extracranial radiation

Mean extracranial dose (% of prescription dose)

Distance from Isocentre (cm)

Source: Neurosurgery, volume 61, Sept 07. Christer Lindquist, MD and Ian Paddick, MSc, Cromwell Hospital, London, UK.
Gamma Knife surgery - preferred for a reason
Gamma Knife Radiotherapy after Metastatic Tumor Resection

Jeff W. Chen, MD, PhD
Neurological Surgery
Jeff W. Chen, MD, PhD
Legacy Gamma Knife Meeting
November 7, 2013

“Gamma Knife Radiotherapy after Metastatic Tumor Resection”

Disclosure of relevant financial relationships in the past 12 months:

- Jeff Chen has disclosed that he has no relevant financial relationships with commercial entities producing health-care related products and/or services
Brain Mets- Background

- 20-40% of cancer patients will develop one or more brain metastases
- The incidence has increased because of improved survival of cancer patients and improved detection techniques
- The most frequent cancers that metastasize to the brain include lung, breast, melanoma and colon.
- 150,000-200,000 patients/yr in the US are diagnosed with a metastatic brain tumor
The data for surgery and WBRT

- WBRT after surgical resection has been shown to decrease death from Neurologic causes
- Local control with WBRT = 90%, without = 54%
- Distant control with WBRT = 82%, without = 54%

- Patchel et al., 1998
What’s the Problem with WBRT?

- Neurocognitive decline-verbal memory
- The risks of WBRT-
  local effects
- Dementia
  > @1 yr after WBRT—11%
  > @2yr after WBRT-50%

The Data for SRS to the tumor bed

- Jensen et al., 2011
  - 112 resection cavities in 106 patients (no prior WRBT)
  - Treatment of the tumor bed (57.5%) or also the synchronous lesion (24.5%)
  - Local tumor control rate=80.3% @ 1 yr
  - Distant control rate=35.4% @ 1yr
  - Median overall survival= 10.9 Months
  - Need for salvage WBRT=45.9% @ 1yr
The Data for SRS to the tumor bed

- Jensen et al., 2011
  > Patients with tumor diameters > 3.0 cm had a higher risk of failure
  > Median time to delay for need for WBRT=12.6 months
The Data for SRS to the tumor bed

- Roberge et al, 2012; Gans et al, 2013
  - Critical reviews of the published data
  - Most common technique= 1-3mm clinical target volume margin added, median dose range=15-19Gy
  - Surgical tract is not included in the target
  - Volumes range 0.1 to 66.8 cm$^3$
The Data for SRS to the tumor bed

- Estimated local control rate = 79%, and one-year = 85%
- Necrosis rates = 0-6%
- Salvage WBRT in 29% of cases
Complications with post-op SRS

- 10% incidence in a literature review of 14 studies involving 629 patients
  > Radiation related edema (43%)
  > Radiation necrosis (23%)

  > Gans et al., 2013
67 yo F with hx of lung CA (non-small cell-dx 11/2012) Pre-op (4/30/13)
67 yo F with hx of lung CA post-op (6/25/13)
67 yo F with hx of lung CA  
s/p gamma knife (9/20/13)  

15 g to the 50% line in 23 shots
Gamma Knife is one component of the treatment paradigm- a team approach
29 yo F Rectal CA
New onset aphasia
29 yo F Rectal CA
New onset aphasia
29 yo F Rectal CA
New onset aphasia

- Temporal and frontal craniotomy for tumor resection
- Post-op improved—speech has returned to normal
29 yo F Rectal CA
New onset aphasia
29 yo F Rectal CA
New onset aphasia
Post-op considerations

- Further adjuvant therapy?
- Gamma knife to the tumor bed
- Gamma knife to the synchronous lesion
Selected References


Selected References

Gamma Knife has come to Legacy 5/13/2013
Gamma Knife has come to Legacy 5/13/2013
The Future

- There is a trend towards surgical resection and SRS to the cavity
- Alliance for Clinical Trials in Oncology prospective randomized trial NCCTG-N107C, a phase III trial (1-4 metastatic brain tumors after resection of 1)
Gamma Knife Stereotactic Radiosurgery

Andrew Kee, MD
Over 676,000 patients treated with Leksell Gamma Knife worldwide through 2011

Cumulative, thousands

Source: Leksell Gamma Knife Society 68-100% sites reporting
Cumulative Case Mix 1968-2011

- Malignant Tumors: 296,867
- Benign Tumors: 243,440
- Vascular disorders: 83,367
- Functional disorders: 50,192
- Other disorders: 2,636

Source: Leksell Gamma Knife Society 68-100% sites reporting
Brain Metastasis

- Incidence ~170,000 per year in the US
- Approximately 30–40% of all cancer patients develop brain metastases
- Common primaries
  - Lung 48%
  - Breast 15%
- Local Control: ~80%
Brain Metastasis: Prognosis

- KPS
- Tumor Volume
- Age

Sperduto et al. JCO 2011
Malignant Glioma

- Prognostic variables: Age & KPS
- Dose: 15-24 Gy
- Palliative
Meningioma

- 15-20% primary brain tumors
- Benign (WHO grade I): 90%
- Atypical (WHO grade II): 5-7%
- Anaplastic: (WHO grade III): 1-3%
- Dose: 12-18 Gy
Acoustic Neuroma

93-98% Local Control

Mendenhall et al. Principles and Practice SRS. pp. 278
Pituitary Adenoma: Non Functioning

- Evaluate hormone levels
- Surgery to relieve mass affect on chiasm
- Local control: 90-95%
- Fractionated RT if too close to chiasm/optic nerve

3.5 years
Pituitary Adenoma: Functional tumors

- Off medication therapy for 3-6 weeks prior to GK SRS
- Dose: 25 Gy
- Biochemical remission based on type of tumor
- Tumor control: 91-96%

Pollack et al Neurosurgery 2008
Head and Neck Tumors

- Nasopharynx (T4 tumors or as boost) after conventional IMRT radiotherapy
- Recurrent tumors
- Skull base invasion
Skull Base Tumors

- Craniopharyngioma
- Chordoma
- Chondrosarcoma
- Esthesioneuroblastoma
- Glomus tumors: 90% LC
  - 30% shrink
  - 60% remain stable
  - 50% will have symptoms improve
Arteriovenous Malformation

- Combination of angiogram, MR angiogram, and CT angiogram
- Untreated

Annual mortality rate: 1%
2-4% per year bleed risk

Pollack et al. Principles and Practice SRS. pp. 460
Kano et al. JNS 2012 pp. 11-20
Trigeminal Neuralgia

- Classic TN (Type I)
- No secondary cause (MRI)
- Medication refractory or patients unable to tolerate medications
  - Carbamazepine
  - Oxcarbazepine
  - Baclofen (with or without Lamotrigine)
Pediatric GK SRS

SRS  2 mos.  3.5 mos.  6 mos.
Others

- Cavernoma
- Choroid melanomas
- Psychiatric disorders
- Dural arteriovenous fistulas
- Epilepsy
- Movement disorders
Our Team

“A chain is never stronger than the weakest link”

William James
Alternative: Linear Accelerator
Local Control and Dose: Meningioma

Kollova et al JNS 2007
Fractionated Stereotactic Radiotherapy
Thank you!
Our legacy is yours.

Question & Answer Session
Thank you!