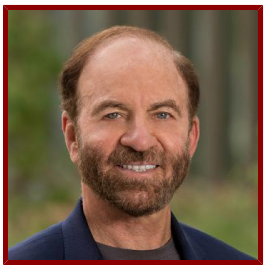
Stanford



Gary K. Steinberg, MD, PhD

Bernard and Ronni Lacroute-William Randolph Hearst Professor of Neurosurgery and Neurosciences and Professor, by courtesy, of Neurology and Neurological Sciences

CLINICAL OFFICE (PRIMARY)

- **Stanford Neuroscience Health Center**

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ACADEMIC CONTACT INFORMATION

- **Alternate Contact**

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Bio

BIO

Dr. Gary Steinberg is the Director of the Stanford Moyamoya Center, the founder and Co-Director of the Stanford Stroke Center, and the former Chair of the Department of Neurosurgery. As a cerebrovascular and skull base neurosurgeon, he specializes in treating brain aneurysms, moyamoya disease, brain and spinal AVMs and other vascular malformations, carotid artery disease, meningiomas, skull base tumors, stroke, and hereditary hemorrhagic telangiectasia.

Dr. Steinberg has practiced neurosurgery at Stanford for more than 31 years. He has pioneered microsurgical techniques to repair intracranial vascular malformations and certain aneurysms that were previously considered untreatable. He has also refined revascularization techniques for patients with cerebrovascular arterial occlusions, as well as moyamoya disease. He is leading novel clinical trials of stem cell therapy for stroke and spinal cord injury.

CLINICAL FOCUS

- Cerebrovascular and Spinal Vascular Surgery
- Intracranial Aneurysms
- Intracranial/Intraspinal AVMs, AV fistulas, Cavernous Malformations
- Moyamoya Disease and Occlusive Cerebrovascular Disease
- Carotid Endarterectomy
- Neurological Surgery

ACADEMIC APPOINTMENTS

- Professor, Neurosurgery
- Professor (By courtesy), Neurology and Neurological Sciences
- Member, Bio-X
- Member, Cardiovascular Institute
- Member, Wu Tsai Neurosciences Institute

ADMINISTRATIVE APPOINTMENTS

- Chair, Stanford University School of Medicine - Neurosurgery, (1995-2020)
- Founder and Co-Director, Stanford Stroke Center, (1991- present)
- Director, Stanford Moyamoya Center, (1991- present)

PROFESSIONAL EDUCATION

- Residency: Stanford University Dept of Neurosurgery (1987) CA
- Residency: Stanford University Dept of General Surgery (1983) CA
- Medical Education: Stanford University School of Medicine (1980) CA
- Residency: Santa Clara Valley Medical Center (1986) CA
- Board Certification: Neurological Surgery, American Board of Neurological Surgery (1989)
- Fellowship: Institute Of Neurology (1981) England

LINKS

- My Lab Site: http://med.stanford.edu/steinberg-lab.html
- Video Story: Choosing Medicine: https://stanfordhealthcare.org/stanford-health-care-now/why-i-got-into-medicine/why-medicine-gary-steinberg-md-phd.html
- Video Story: Alumni Award: https://youtu.be/Sd2KV1Qtyb4

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

Our laboratory is interested in elucidating the pathophysiology of acute cerebral ischemia and in developing neuroprotective treatments, as well as methods to restore neurologic function after stroke. Using rodent wild type, knock out and transgenic models of focal and global ischemia, we are investigating the physiologic processes leading from decreased blood flow after arterial occlusion to irreversible brain injury. A major focus of our work concerns the role of oxidative stress, inflammation and gene expression on necrotic and apoptotic mechnisms of ischemic cell death. Alterations in cerebral blood flow, neuronal metabolic activity, electrophysiology, and gene/protein expression are examined in relation to neurologic behavior. We are also studying the brain microenvironment during recovery after stroke and the effects of stem cell transplantation and optogeneticstimulations in promoting recovery of function.

We have been successful in attenuating ischemic cerebral damage by inducing mild brain hypothermia (30-33 degrees C) or overexpression of various genes (glucose transporter, bcl-2, hsp70, calbindin, catalase, glutathione peroxidase, SOD) either before or after stroke. Transplantation of human neural stem cells after experimental stroke results in survival, targeted migration and differentiation into appropriate neuronal and glial cell types, while anti-inflammatory treatment enhances native neurogenesis and gliagenesis following stroke. Additionally, stem cell transplantation and optogenetic stimulation restores motor-sensory behavior after stroke and we are exploring the underlying circuit plasticity and molecular changes that are responsible for recovring neurologic function.

Methodologies utilized in the laboratory include microsurgery, light and confocal microscopy, stereology, molecular biology techniques, FACS, magnetic resonance imaging, electrophysiology, cerebral blood flow measurements, gene transfer therapy, optogenetics, stem cell transplantation and rodent behavioral analysis.

Our clinical research efforts focus on novel approaches for treating intracranial aneurysms, intracranial and spinal vascular malformations, occlusive cerebrovascular disease such as Moyamoya disease and stroke. These include advances in microsurgery, interventional neuroradiology, stereotactic radiosurgery, 3D imaging, surgical navigation, revascularization techniques, the use of mild brain hypothermia and other clinical neuroprotective agents, and stem cell transplantation for stroke and spinal cord injury.

CLINICAL TRIALS

- A Safety and Tolerability Study of Neural Stem Cells (NR1) in Subjects With Chronic Ischemic Subcortical Stroke (ISS), Recruiting
- A Study of Modified Stem Cells in Stable Ischemic Stroke, Not Recruiting
- Dose Escalation Study of AST-OPC1 in Spinal Cord Injury, Not Recruiting
- Prediction of Outcomes After Surgery for Unruptured Intracranial Aneurysms, Not Recruiting

Teaching

STANFORD ADVISEES

Postdoctoral Faculty Sponsor

Lindsey Druschel, Varun Gupta, Hee Jae Ko, Yuyo Maeda

GRADUATE AND FELLOWSHIP PROGRAM AFFILIATIONS

- Neurosciences (PhD Program)

Publications

PUBLICATIONS

- **Prognostic Nuances in the Microsurgical Resection of Arteriovenous Malformations in Areas of Critical Brain Function: A 25-Year Retrospective Cohort Study.** *Neurosurgery*
  Stuart, M. J., Steinberg, G. K.
  2026
- **Towards Improved Outcomes for Cavernous Malformations of the Brainstem and Other "Critical" Function Brain Regions.** *Neurosurgery*
  Ekanayake, J., Luo, I., Steinberg, G. K.
  2026
- **Achieving better outcomes in treatment of vascular malformations in brainstem and other 'critically' eloquent brain regions - a novel surgical paradigm**
  Ekanayake, J., Luo, I., Steinberg, G.
  LIPPINCOTT WILLIAMS & WILKINS.2026
- **Functional preservation after microsurgical resection of eloquent AVMs is related to eloquence subtype**
  Stuart, M., Steinberg, G.
  LIPPINCOTT WILLIAMS & WILKINS.2026
- **Outcomes of brainstem cavernous malformation resection, without and with use of a flexible omnidirectional carbon dioxide laser: a single-surgeon series of 277 surgical procedures.** *Journal of neurosurgery*
  Gauden, A. J., Choi, J. L., Luo, I., Han, S. S., Steinberg, G. K.
  2025: 1-8
- **Clinical state and future directions of stem cell therapy in stroke rehabilitation.** *Experimental neurology*
  Habib, P., Steinberg, G. K.
  2024: 115132
- **Genome-Wide DNA Methylation Profiling Reveals Low Methylation Variability in Moyamoya Disease.** *Translational stroke research*
  Tokairin, K., Ito, M., Lee, A. G., Teo, M., He, S., Cheng, M. Y., Steinberg, G. K.
  2024

- **Prevalence of Systemic Hypertension and the Effects of Cerebral Revascularization in Patients With Moyamoya Disease** *STROKE-VASCULAR AND INTERVENTIONAL NEUROLOGY*
  Lee, H., Ahmed, U., Bell-Stephens, T., Steinberg, G. K.
  2024; 4 (3)
- **Incidence and Outcomes of Posterior Circulation Involvement in Moyamoya Disease.** *Stroke*
  Tigchelaar, S. S., Wang, A. R., Vaca, S. D., Li, Y., Steinberg, G. K.
  2024
- **Stanford University School of Medicine: Our Neurosurgical Heritage.** *Neurosurgery*
  Veeravagu, A., Kim, L. H., Rao, V. L., Lim, M., Shuer, L. M., Harris, O. A., Steinberg, G. K.
  2023
- **Short- and long-term outcomes of moyamoya patients post-revascularization** *JOURNAL OF NEUROSURGERY*
  Teo, M., Abhinav, K., Bell-Stephens, T. E., Madhugiri, V. S., Sussman, E. S., Azad, T., Ali, R., Esparza, R., Zhang, M., Steinberg, G. K.
  2023; 138 (5): 1374-1384
- **First-in-human Phase 1/2a Study Of Intracerebral Transplantation Using Embryonic-derived Neural Stem Cells (NR1) For Chronic Ischemic Stroke**
  Steinberg, G. K., Bet, A., Williams, J., McDonald, K., Diaz, R., Samos, C., Trisler, K., Weissinger, J., Coburn, M., Tong, E., Schwartz, N.
  AMER ASSOC NEUROLOGICAL SURGEONS.2023
- **Decoding the molecular crosstalk between grafted stem cells and the stroke-injured brain.** *Cell reports*
  Azevedo-Pereira, R. L., Manley, N. C., Dong, C., Zhang, Y., Lee, A. G., Zatulovskaia, Y., Gupta, V., Vu, J., Han, S., Berry, J. E., Bliss, T. M., Steinberg, G. K.
  2023; 42 (4): 112353
- **Comprehensive Profiling of Secreted Factors in the Cerebrospinal Fluid of Moyamoya Disease Patients.** *Translational stroke research*
  Abhinav, K., Lee, A. G., Pendharkar, A. V., Bigder, M., Bet, A., Rosenberg-Hasson, Y., Cheng, M. Y., Steinberg, G. K.
  2023
- **Radiosurgery as a microsurgical adjunct: outcomes after microsurgical resection of intracranial arteriovenous malformations previously treated with stereotactic radiosurgery.** *Journal of neurosurgery*
  Bigder, M., Choudhri, O., Gupta, M., Gummidipundi, S., Han, S. S., Church, E. W., Chang, S. D., Levy, R. P., Do, H. M., Marks, M. P., Steinberg, G. K.
  2021: 1-12
- **Basal ganglia cavernous malformations: case series and systematic review of surgical management and long-term outcomes.** *Journal of neurosurgery*
  Li, Y. n., Khahera, A. n., Kim, J. n., Mandel, M. n., Han, S. S., Steinberg, G. K.
  2021: 1–9
- **Brain-wide neural dynamics of poststroke recovery induced by optogenetic stimulation.** *Science advances*
  Vahdat, S., Pendharkar, A. V., Chiang, T., Harvey, S., Uchino, H., Cao, Z., Kim, A., Choy, M., Chen, H., Lee, H. J., Cheng, M. Y., Lee, J. H., Steinberg, et al
  2021; 7 (33)
- **Unique Subtype of Microglia in Degenerative Thalamus After Cortical Stroke.** *Stroke*
  Cao, Z. n., Harvey, S. S., Chiang, T. n., Foltz, A. G., Lee, A. G., Cheng, M. Y., Steinberg, G. K.
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- **Clinical Course of Unilateral Moyamoya Disease.** *Neurosurgery*
  Church, E. W., Bell-Stephens, T. E., Bigder, M. G., Gummidipundi, S., Han, S. S., Steinberg, G. K.
  2020
- **Treatment of posterior circulation fusiform aneurysms.** *Journal of neurosurgery*
  Church, E. W., Bigder, M. G., Sussman, E. S., Gummidipundi, S. E., Han, S. S., Heit, J. J., Do, H. M., Dodd, R. L., Marks, M. P., Steinberg, G. K.
  2020: 1–7
- **Functional Outcomes After Revascularization Procedures in Patients With Hemorrhagic Moyamoya Disease** *NEUROSURGERY*
  Abhinav, K., Furtado, S., Nielsen, T. H., Iyer, A., Gooderham, P. A., Teo, M., Lee, J., Han, S. S., Steinberg, G. K.

2020; 86 (2): 257–65

- **Incidental De Novo Cerebral Microhemorrhages are Predictive of Future Symptomatic Macrohemorrhages After Surgical Revascularization in Moyamoya Disease.** *Neurosurgery*
  Li, Y. n., Esene, I. n., Mandel, M. n., Bigder, M. n., Steinberg, G. K.
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- **Direct versus indirect bypass procedure for the treatment of ischemic moyamoya disease: results of an individualized selection strategy.** *Journal of neurosurgery*
  Nielsen, T. H., Abhinav, K. n., Sussman, E. S., Han, S. S., Weng, Y. n., Bell-Stephens, T. n., Heit, J. J., Steinberg, G. K.
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- **Trans-Lamina Terminalis Approach to Laser-Assisted Resection of Thalamo-mesencephalic Cavernous Malformation.** *World neurosurgery*
  Bigder, M. G., Li, Y. n., Mandel, M. n., Steinberg, G. n.
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- **Revisiting Stem Cell-Based Clinical Trials for Ischemic Stroke.** *Frontiers in aging neuroscience*
  He, J. Q., Sussman, E. S., Steinberg, G. K.
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- **Two-year safety and clinical outcomes in chronic ischemic stroke patients after implantation of modified bone marrow-derived mesenchymal stem cells (SB623): a phase 1/2a study** *JOURNAL OF NEUROSURGERY*
  Steinberg, G. K., Kondziolka, D., Wechsler, L. R., Lunsford, L., Kim, A. S., Johnson, J. N., Bates, D., Poggio, G., Case, C., McGrogan, M., Yankee, E. W., Schwartz, N. E.
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- **Multimodal management of arteriovenous malformations of the basal ganglia and thalamus: factors affecting obliteration and outcome** *JOURNAL OF NEUROSURGERY*
  Madhugiri, V. S., Teo, M. K. C., Westbroek, E. M., Chang, S. D., Marks, M. P., Do, H. M., Levy, R. P., Steinberg, G. K.
  2019; 131 (2): 410–19
- **Microsurgical laser resection of brainstem cavernous malformations.** *Neurosurgical focus: Video*
  Church, E. W., Steinberg, G. K.
  2019; 1 (1): V7
- **Functional Outcomes After Revascularization Procedures in Patients With Hemorrhagic Moyamoya Disease.** *Neurosurgery*
  Abhinav, K., Furtado, S. V., Nielsen, T. H., Iyer, A., Gooderham, P. A., Teo, M., Lee, J., Han, S. S., Steinberg, G. K.
  2019
- **Surgical Treatment of Recurrent Previously Coiled and/or Stent-Coiled Intracerebral Aneurysms: A Single-Center Experience in a Series of 75 Patients** *WORLD NEUROSURGERY*
  Liu, J. J., Nielsen, T. H., Abhinav, K., Lee, J., Han, S. S., Marks, M. P., Do, H. M., Dodd, R. L., Steinberg, G. K.
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- **Two-year safety and clinical outcomes in chronic ischemic stroke patients after implantation of modified bone marrow-derived mesenchymal stem cells (SB623): a phase 1/2a study.** *Journal of neurosurgery*
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- **Multimodal management of arteriovenous malformations of the basal ganglia and thalamus: factors affecting obliteration and outcome.** *Journal of neurosurgery*
  Madhugiri, V. S., Teo, M. K., Westbroek, E. M., Chang, S. D., Marks, M. P., Do, H. M., Levy, R. P., Steinberg, G. K.
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- **Stem Cell-Based Immunomodulation After Stroke: Effects on Brain Repair Processes** *STROKE*
  Boshuizen, M. C. S., Steinberg, G. K.
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- **Engineered stem cell mimics to enhance stroke recovery.** *Biomaterials*
  George, P. M., Oh, B. n., Dewi, R. n., Hua, T. n., Cai, L. n., Levinson, A. n., Liang, X. n., Krajina, B. A., Bliss, T. M., Heilshorn, S. C., Steinberg, G. K.

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- **Long-Term Effectiveness of Gross-Total Resection for Symptomatic Spinal Cord Cavernous Malformations.** *Neurosurgery*
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- **Electrical preconditioning of stem cells with a conductive polymer scaffold enhances stroke recovery.** *Biomaterials*
  George, P. M., Bliss, T. M., Hua, T. n., Lee, A. n., Oh, B. n., Levinson, A. n., Mehta, S. n., Sun, G. n., Steinberg, G. K.
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- **Clinical Outcomes of Transplanted Modified Bone Marrow-Derived Mesenchymal Stem Cells in Stroke A Phase 1/2a Study** *STROKE*
  Steinberg, G. K., Kondziolka, D., Wechsler, L. R., Lunsford, L. D., Coburn, M. L., Billigen, J. B., Kim, A. S., Johnson, J. N., Bates, D., King, B., Case, C., McGrogan, M., Yankee, et al
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  Cheng, M. Y., Aswendt, M., Steinberg, G. K.
  2016; 13 (2): 325-340
- **Enhanced phasic GABA inhibition during the repair phase of stroke: a novel therapeutic target** *BRAIN*
  Hiu, T., Farzampour, Z., Paz, J. T., Wang, E. H., Badgely, C., Olson, A., Micheva, K. D., Wang, G., Lemmens, R., Tran, K. V., Nishiyama, Y., Liang, X., Hamilton, et al
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- **Novel Stroke Therapeutics: Unraveling Stroke Pathophysiology and Its Impact on Clinical Treatments.** *Neuron*
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- **Is local hypoperfusion the reason for transient neurological deficits after STA-MCA bypass for moyamoya disease?** *JOURNAL OF NEUROSURGERY*
  Mukerji, N., Cook, D. J., Steinberg, G. K.
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- **Disease Variant Landscape of a Large Multiethnic Population of Moyamoya Patients by Exome Sequencing.** *G3 (Bethesda, Md.)*
  Shoemaker, L. D., Clark, M. J., Patwardhan, A., Chandratillake, G., Garcia, S., Chen, R., Morgan, A. A., Leng, N., Kirk, S., Chen, R., Cook, D. J., Snyder, M., Steinberg, et al
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- **Optogenetic neuronal stimulation promotes functional recovery after stroke** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
  Cheng, M. Y., Wang, E. H., Woodson, W. J., Wang, S., Sun, G., Lee, A. G., Arac, A., Fenno, L. E., Deisseroth, K., Steinberg, G. K.
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- **Flexible Omnidirectional Carbon Dioxide Laser as an Effective Tool for Resection of Brainstem, Supratentorial, and Intramedullary Cavernous Malformations** *NEUROSURGERY*
  Choudhri, O., Karamchandani, J., Gooderham, P., Steinberg, G. K.
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  Navarro, R., Chao, K., Gooderham, P. A., Bruzoni, M., Dutta, S., Steinberg, G. K.
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- **A Novel Phase 1/2A Study of Intraparenchymal Transplantation of Human Modified Bone Marrow-Derived Cells in Patients With Stable Ischemic Stroke**
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  Darsaut, T. E., Darsaut, N. M., Chang, S. D., Silverberg, G. D., Shuer, L. M., Tian, L., Dodd, R. L., Do, H. M., Marks, M. P., Steinberg, G. K.
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