
BREAKTHROUGHS IN NEUROSURGERY
Stanford
MEDICINE

A huge wave slammed him into the sand. Matthew Ryan had taken his two kids to the beach to give his pregnant wife Sara a break. One minute he was giving his son a boogie board demonstration, and the next minute he couldn't feel his body.

As a physical therapist, he knew he was in trouble. "It was surreal," he says. "I was looking up and could see the sun through the water. I thought, 'This is it. This is my last vision.' Then I started thinking that if I lived, I'd be a quadriplegic and a big burden to my family."

Multiple spine fractures and ligament injuries pushed against Matthew's spinal cord. For seven hours, his neurosurgeon maneuvered through the vertebrae with precision. He reset dislocations and picked out fragments of cartilage while avoiding nerves and the spinal cord. Finally, he placed a protective titanium cage around Matthew's injuries.

Just three days later, Matthew stood at his wife's side as he cut the umbilical cord of their new baby girl. As a lifelong athlete, being able to swim, cycle, and start a martial arts routine was a big deal. But it was nothing compared to being able to run and play with his kids. "I'm truly a walking miracle," he says. "I'm so very lucky to have my life."

◀ *Matthew Ryan's job as a physical therapist is to help people get their lives back. He's also pictured on both covers.*

BUILDING BETTER BACKS

More than half a billion people around the world suffer from back pain and nearly half a million Americans are living with spinal cord injury. And even though neck and back operations are the third most common form of surgery in the U.S., comprehensive information on outcomes for these procedures is simply not available.

That's why the Stanford Neurospine Center has developed the nation's first integrated data capturing and analysis system for evaluating patient outcomes after spinal surgery. With this information, clinicians around the world will finally be able to determine which treatments are most successful at minimizing pain and maximizing quality of life.

But we're doing far more than just evaluating–we're performing state-of-the-art spine surgeries every day. Whether a patient comes to us with a degenerative spine disease, a spinal cord injury, or a spinal tumor, our neurosurgeons are using minimally invasive techniques to preserve or even restore function with less risk and faster recovery than ever before. And in the lab, we're not just developing prosthetic disc technologies and spinal devices, we're also investigating biological regeneration of discs, nerves, and the spinal cord.

"Mommy, my arm feels funny again." That's how moyamoya disease, a tangle of blood vessels at the base of the brain, felt to 7-year-old Reddy Lee. His parents Greg and Gina learned he was actually having small strokes and needed immediate surgery. Because moyamoya is so rare, only a few medical centers in the country had the expertise to restore their son's health.

Greg and Gina switched into high gear, interviewing neurosurgeons at three specialized medical centers. Should they fly Reddy across the country to Stanford or stay on the East Coast? "When we learned that a family friend with moyamoya was successfully treated by the Stanford team," Gina says, "we were on a plane in two days."

"I want to be sure no other child has to have brain surgery," Reddy told his parents after his recovery. For his next birthday, he asked friends and family to contribute to the Reddy Lee Fund for Moyamoya Research at Stanford.

Paraphrasing Gandhi, Reddy's birthday invitation said, "I want to be the change in the world." His Stanford team has no doubt he will be now that he's a healthy teenager.

◀ *Reddy Lee hams it up on the beach.*

WHEN NO ONE ELSE CAN HELP

Patients with rare disorders struggle to find doctors who specialize in their diseases. They often search for years before finding expert help. But thanks to the uncommon dedication of two neurosurgeons, programs were established at Stanford to provide accurate diagnosis and leading-edge treatment for two of these unusual conditions.

The Stanford Moyamoya Center is the world's largest treatment and research center for this rare disease. With our decades of experience, our innovative surgical approaches, and our commitment to training clinicians around the globe, we're improving diagnosis, access, and outcomes for moyamoya patients everywhere.

The Clinical Neurogenetic Oncology Program at Stanford is one of a select group of programs worldwide dedicated to another rare disorder. It offers advanced care for patients with neurogenetic tumors, which repeatedly assault the nervous system and are extremely difficult to treat. At Stanford, these courageous patients and their families find the expertise, coordinated care, and compassionate support they need in their fight against this heartbreaking and as yet incurable disorder.

Boris Seibert thought he just needed glasses. His vision was fuzzy, and reading emails was tiring. Glare from oncoming headlights made him afraid to drive at night. And weirdly, he kept bumping into things—but only on his left side. At 40, he figured he was just "getting old."

A vision test raised the alarm, and Boris was advised to get an MRI immediately. When the scan confirmed a tumor was pressing on his brain and optic nerve, he went into overdrive. A self-described "super researcher," he found a series of informational videos about pituitary cancer on the Stanford Neurosurgery website.

He learned there was a less invasive alternative to the open-brain surgery traditionally performed for pituitary tumors like his. After meeting with the Stanford Neurosurgery team, he didn't hesitate. It took him just a few weeks to recover after they successfully removed the tumor—through his nose.

"My eyesight did come back after the surgery," Boris says with relief. "I can't imagine not being able to watch my daughter grow up. Now I'm wearing glasses, but it's definitely related to age and not a tumor!"

◀ *Boris Seibert and his daughter admire jellyfish at the Monterey Bay Aquarium.*

SURGERY WITHOUT SCALPELS

Stanford is breaking new ground with minimally invasive neurosurgical techniques that offer our patients faster recovery with less risk of complications. Using image guidance systems, video endoscopy, robotic assistance, and specialized surgical instruments, Stanford neurosurgeons are often able to access and repair the brain and spine through very small openings.

As Boris's story illustrates, the Stanford Pituitary Center offers patients just such an alternative to major open-brain surgery for pituitary tumors. In many cases, other small tumors like acoustic neuromas can be treated on an outpatient basis with CyberKnife, a precision low-dose radiation technology invented at Stanford. With sub-millimeter accuracy, CyberKnife's focused beams of radiation act like a scalpel, but with less chance of damaging nearby cells.

Vascular problems like aneurysms, blockages, and malformations can be treated from inside blood vessels. And in two exciting new clinical trials, our neurospecialists are using lasers to treat epilepsy and focused ultrasound to relieve tremors and pain without a single scalpel.

I'm watching

A player is down. A hush falls over the crowd. The coach runs onto the field. Parents worry from the stands. It's a scene that's played out again and again on athletic fields around the world.

Sports concussions are a leading cause of disability in kids and young adults. They can result in serious and permanent issues with memory, attention, and problem-solving skills. Weighing the benefits of playing against the health risks to kids is tough on parents—and the fact that concussions can be difficult to spot makes it even tougher.

That's why Stanford coach Amy Bokker is always on the lookout. "The health of our athletes is our top priority," she says. "We monitor players both on and off the field for any signs of injury, but concussions are tricky. Evidence-based standards to accurately diagnose them and determine when it's safe for an athlete to play will be a huge help."

From portable eye movement trackers to detect concussion, to new concussion classification and treatment systems, to research into the brain's ability to repair itself, Stanford scientists, clinicians, and coaches are working together to make sports safer. It's a team effort that will have a positive impact far beyond Cardinal territory.

◀ *Stanford lacrosse coach Amy Bokker watches more than the scoreboard.*

CONFRONTING CONCUSSIONS

Stanford is a world leader in the diagnosis, treatment, and prevention of concussions. At our Concussion and Brain Performance Center, researchers and clinicians are working with schools, the NCAA, and professional sporting groups to develop concussion education and awareness programs. They're also developing innovative ways to fight concussions, including a portable device that tracks eye movements to help with detection, a "smart" mouth guard that measures the force and direction of hits, and a helmet that redirects force from the neck to the shoulders.

But the Center's impact extends far beyond the playing field. It's changing the way concussions are treated. At Stanford Health Care, concussion patients are fast-tracked through the emergency department to the clinic, where they're treated with an emphasis on early rehabilitation.

The Center was also chosen by the Department of Defense to establish a multi-institutional consortium to develop a new brain trauma classification system that will lead to more effective diagnostics and therapeutics. This work and the work of Stanford Health Care's neurocritical care team will benefit all those who suffer brain injuries, whether they occur on the playing field, the battlefield, or anywhere else.

Olympic medalist Davis Phinney is one of the most successful cyclists in American history. He retired from professional bike racing in 1993 and went on to champion his sport as a national network sportscaster. In 2000, after years spent fighting fatigue, mental fogginess, numbness, and shakiness, he was diagnosed with early-onset Parkinson's disease. He was only 40.

"It was very, very sobering," he says. "With Parkinson's, your goal is to stem the decline. It's the opposite of the Olympics. Instead of reaching for a high point, you're just trying not to get to a low point as quickly." When he heard there was a pacemaker-like device that could control his symptoms, he jumped at the chance.

He was amazed after the device was implanted at Stanford. "Before, my tremor was fierce. The DBS [deep brain stimulation] quelled it to a very large degree. It's proven incredibly effective."

"I win every day now," proclaims Davis. In 2004, he started the Davis Phinney Foundation to support innovative research and improve the lives of people living with Parkinson's. Since then, he's inspired millions of people with his optimism and advocacy.

◀ *World-renowned cyclist and Parkinson's disease research advocate Davis Phinney on the road in Colorado.*

FINE TUNING BRAIN CIRCUITS

Our growing ability to observe and control the brain's circuitry is making a huge difference in the lives of patients with Parkinson's disease and other neurologic disorders. Deep brain stimulation (DBS), which modulates electrical circuits in the brain, has been reducing tremors in patients like Davis for years.

Now we're testing second-generation devices that we hope will regulate symptoms in real time. We're also using DBS for other disorders. Two Stanford clinical trials have shown that electrical stimulation both on the surface and inside the brain decreases seizures in patients with epilepsy, and trials exploring DBS for depression, obesity, and obsessive compulsive disorder are in the works.

Other exciting neuromodulation technologies being tested in our clinics include CyberKnife for psychiatric conditions, focused ultrasound for tremor, and coordinated reset stimulation for tinnitus, epilepsy, pain, and Parkinson's – all of which are completely non-invasive. And a revolutionary research tool developed at Stanford that stimulates neurons with light also holds therapeutic promise – it's already been shown to promote stroke recovery in mice.

Juri Kameda isn't one to let the world pass her by. Even though she has amyotrophic lateral sclerosis (ALS) and is partially paralyzed, she went skydiving and posted a video of it on YouTube to encourage others with ALS to be actively engaged with life.

ALS will ultimately leave Juri totally paralyzed and unable to speak. So when she heard about the BrainGate2 multi-site clinical trial, she immediately said, "Let's do it!" Using revolutionary brain-computer interface technology, BrainGate2 explores whether severely paralyzed people can control a computer cursor or robotic arm by thought alone.

Juri immediately embraced her role on the research team. "While there's still more progress to be made, this kind of technology is something we could only dream of when I was studying cognitive science," Juri says. The team is integrating her insights and ideas about system design into its planning.

Participating in the trial has given her new purpose. And knowing that her voice may be heard in the years ahead keeps her going. "Just because I won't be able to speak," she quips, "doesn't mean I won't have anything to say. I'll always have a lot to say."

◀ *Just by concentrating, Juri Kameda can "type" with the neural interface system.*
CAUTION: Investigational Device. Limited by Federal Law to Investigational Use.

TOMORROW'S TECH TODAY

Brain-computer interfaces like Juri's use a sensor about the size of a baby aspirin that's placed just into the surface of the brain to pick up tiny electrical signals. These signals are then processed by a computer, and the output is used to control a computer cursor, robotic arm, or other device.

Stanford researchers are also working on the next generation of visual prosthetics to help patients with some types of blindness see. These devices will capture visual input, process it, and stimulate undamaged cells to convey that input to the brain with much more clarity than current technologies.

Complex, cutting-edge research projects like these demand the interdisciplinary collaboration for which Stanford is famous. Every day on our campus, neurosurgeons, neuroscientists, engineers, and computer scientists work side-by-side to create a brighter future for those challenged by injury or disease.

But all their efforts come to nothing without the courage of patients like Juri to help them bring innovations out of the lab and into the clinic. In the words of John Adler, MD, the Stanford neurosurgeon who invented the CyberKnife, "Patients are the unsung heroes of innovation. Someone has to step forward and be the first."

Jeremy Guenther's right hand was numb and partially paralyzed. A brain scan revealed the awful news: He had a tumor the size of a tennis ball—and his doctor estimated he had a month to live. "I was stunned," he says. "As a single dad, my main concern was for my two-year-old daughter. Who was going to be there for her?"

Jeremy's manager immediately sent out a mass email and a friend called Stanford. In less than two hours, Jeremy's phone rang. It was Gary Steinberg, chair of the Stanford Department of Neurosurgery. "We can help," Dr. Steinberg said. "How soon can you get here?"

Four days later, he was awake as the neurosurgical team removed his tumor. First, his pinkie came back to life. Then, feeling and strength returned to all his fingers, one by one. "I knew when they were done because I had total use of my hand. I stuck it back toward Dr. Steinberg and told him to shake it!" Fortunately, the tumor turned out to be benign.

12 hours after surgery Jeremy walked out of the hospital. In three weeks he was back in Nashville producing country hits. "Afterwards, I asked Dr. Steinberg, 'How did this happen?' And he said, 'We don't really know. That's what our researchers are trying to find out.'"

◀ *Jeremy Guenther and his daughter love taking selfies.*

TACKLING COMPLEXITY

In the clinic, operating room, and lab, our clinicians and scientists are tirelessly seeking better solutions for complex nervous system tumors. Even if they're not cancerous, these tumors can have profound impacts on brain, spinal cord, and nerve function. Informed by the latest science, our neurospecialists employ many different approaches to determine the exact nature of a tumor and then deploy the best treatment strategies.

Glioblastoma is the most common and deadliest brain cancer, and our team at the Stanford Brain Tumor Center is searching for better ways to fight it. With colleagues across campus, we're exploring innovative tumor-imaging technologies and procedures. We're one of the few places pioneering new procedures to safely open the blood-brain barrier to allow more effective treatment with more therapeutic agents. And we're working towards blood tests to determine up front who will benefit from which type of therapy.

Our researchers are also exploring ways to harness the immune system to fight tumors. The world's first brain tumor vaccine was developed at Stanford and has led to increased survival rates in many clinical trials. And an exciting Stanford clinical trial is aimed at unmasking hidden cancer cells and enlisting the immune system to fight them.

I'm back

Calling a friend. Getting dressed. Walking the dog. It was all so easy. Then it all became so hard. At age 31, Sonia Olea had a severe stroke. She couldn't speak, walk, or use her right arm.

She regained some function after months of grueling work. But the things that meant the most to her—like talking with her best friend from childhood on the phone—were frustrating, if not impossible.

"This is probably as good as it's gonna get," is what doctors kept telling her. But being a relentless optimist, Sonia refused to give up. She kept searching until she heard about a groundbreaking clinical trial at Stanford—an experimental stem cell therapy for people who had "permanent" damage following a stroke.

A year after Stanford neurosurgeons transplanted millions of neural stem cells directly into the area of her brain injured by the stroke, Sonia was gabbing on the phone, jogging with her dogs, and planning a future with her fiancé.

"I got me back." That's what a smiling Sonia says when asked what this recovery of function has meant to her.

◀ *Sonia Olea now talks up a storm with her best friend almost daily.*

RESTORING FUNCTION

Strokes strike nearly 800,000 Americans every year – that's one every 40 seconds. It's the third most common cause of death and the leading cause of serious, long-term disability in the U.S.

At the Stanford Stroke Center, we're changing the future for stroke patients. Our unparalleled teams of neurosurgeons, neurologists, neurointerventional radiologists, and neuroscientists are developing new imaging techniques, clarifying mechanisms of brain injury and repair, designing new devices, and refining minimally-invasive surgical procedures. They're also exploring new therapies to restore function after stroke, including anti-inflammatory and neuroprotective drugs, brain stimulation, and stem cell transplants like the one Sonia received.

We're recognized as a world leader in stroke research and treatment. We were the first stroke center in the country to earn comprehensive certification from the Joint Commission and we've been designated by the National Institutes of Health as one of only 25 Regional StrokeTrials Coordinating Centers. Sonia's clinical trial is the first North American trial of direct brain stem cell transplantation for stroke. Preliminary results are so encouraging, we're planning larger trials for stroke as well as for spinal cord injury.

Patients come to us from all over the world, and each one is unique. Each brings a different set of experiences and challenges. Yet they all come with the same hope. To regain function lost to disease or injury. To walk, talk, see, work, or play again. To get their lives back.

We're changing the face and future of neurosurgery. Once a singular specialty, neurosurgeons at Stanford now work side-by-side with neurologists, psychiatrists, computational scientists, engineers, stem cell biologists, brain tumor scientists, and others—all bound by a desire to unravel the mysteries of the nervous system and apply this knowledge to some of the most complex disorders of the human condition.

There is no greater honor than when our patients, their families, and the communities we serve join us in this quest. When you choose us for your care, when you participate in clinical trials, and when you support us through philanthropy, you lift us all up and help us aim higher. Thank you for joining Stanford Neurosurgery and Stanford Medicine in giving people their lives back.

Gary K. Steinberg, MD, PhD
Bernard and Ronni Lacroute-William Randolph Hearst Professor
Chair, Stanford University Department of Neurosurgery

YOU CAN GIVE LIVES BACK

As Dr. Steinberg says, "Every day I imagine the time when every person who has suffered devastating neurologic injury or degenerative disease has the opportunity to return to their family, their work, and their community as full participants in life."

With your philanthropic investment in our endeavors to care for patients, discover new treatments, and train the next generation of neurospecialists, you can literally give people here and around the world their lives back.

For personalized information and counsel, please contact our neurosurgery development specialist at 650.725.2504 or medicalgiving@stanford.edu. We can suggest gift opportunities to match your specific interests and situation.

To learn more about the Department of Neurosurgery, visit neurosurgery.stanford.edu. For more information about the Campaign for Stanford Medicine visit medicalgiving.stanford.edu.

For all patient inquiries, call the Adult Neurosurgery Clinic at 650.723.7093 or the Pediatric Neurosurgery Clinic at 650.724.4270.

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