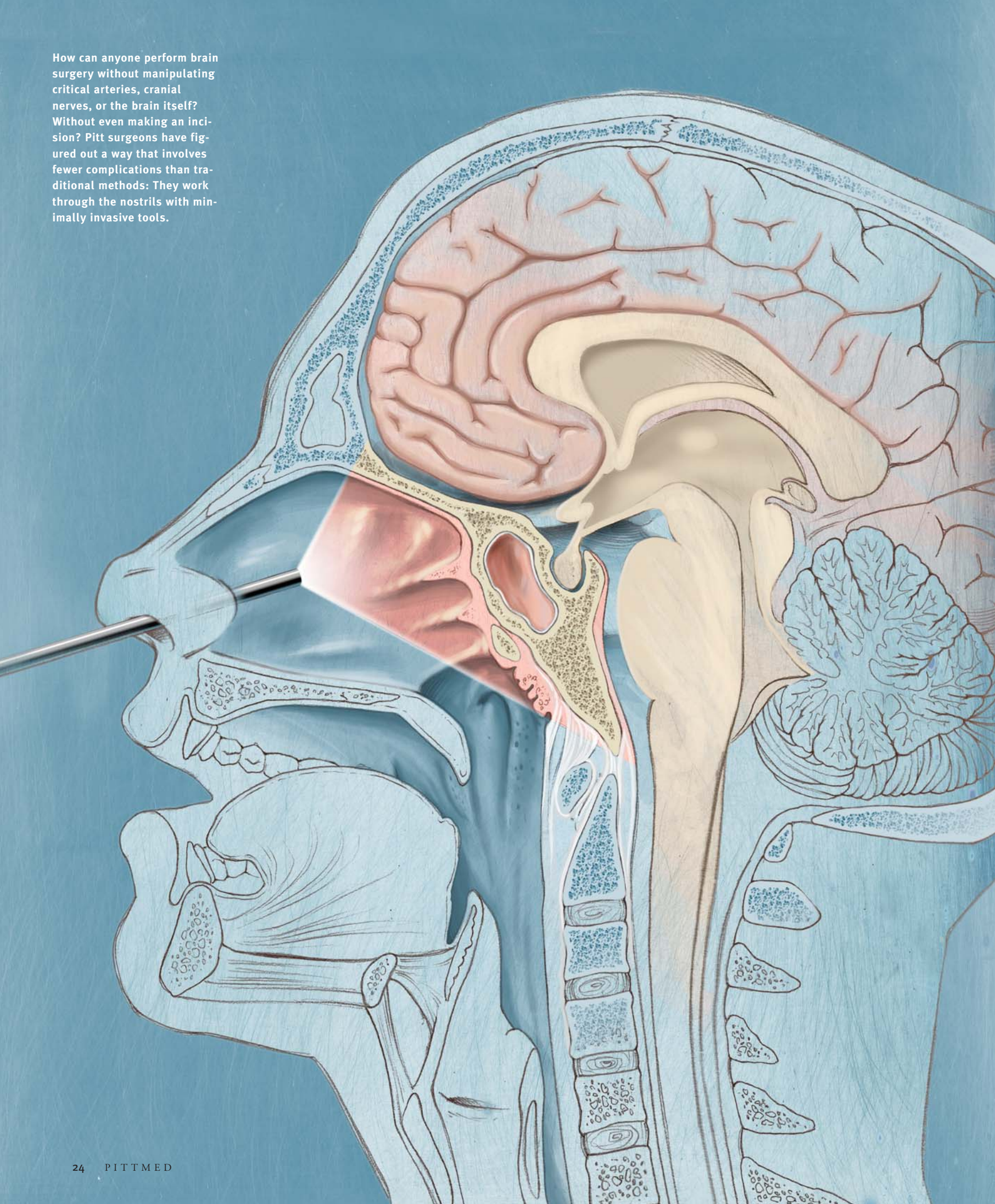
How can anyone perform brain surgery without manipulating critical arteries, cranial nerves, or the brain itself? Without even making an incision? Pitt surgeons have figured out a way that involves fewer complications than traditional methods: They work through the nostrils with minimally invasive tools.



IT'S NOT A GIMMICK, IT'S BRAIN SURGERY THROUGH THE NOSE

BY CHUCK STARESINIC

TWIN PORTALS TO THE BRAIN

Peruse the back issues of a few medical journals, and you will find detailed accounts of surgical innovations performed, at the time they were written, on just a few occasions or perhaps a single time. Spreading the word early on is how the science and art of surgery advance. Being first and publishing first ensures that credit is given where credit is due.

Why, then, did a handful of surgeons in the University of Pittsburgh School of Medicine not say a thing for five years about a new procedure they knew would astound their peers? They were removing cranial tumors the size of baseballs without leaving a scar. They were sending patients home and sometimes even back to work in a matter of days, with no outward sign that these men and women had undergone major brain surgery. They'd performed hundreds of procedures, most of which had the potential to set the neurosurgical field on its cranium, and still not a peep. Forget publishing—they wouldn't even discuss what they were doing with colleagues from other academic medical centers.

ILLUSTRATION | MARTENS & KIEFER

"You try to explain to a neurosurgeon that you took out the upper part of the spine through the nose, and they think you're certifiable at that point."

Amin Kassam, a Pitt associate professor of neurological surgery and one of the key conspirators, explains, "We understood that when we brought the work out, it had to be at a level that it could withstand a lot of important criticism." Then he adds, "The work is just so unimaginable for most neurosurgeons."

This is what was previously unimaginable: using minimally invasive technology to work inside the skull through the nostrils. No incisions. No manipulation of the brain, critical arteries, or cranial nerves. Just one or two long telescopic instruments in each nostril, plus an endoscope. For starters, the surgeons drill a hole the size of a thumbnail through the bottom of the skull. Depending on where they create this opening, they gain access to points inside the skull from behind the brow to the top of the spine and out toward the temples.

Reaching the base of the skull has always been problematic. The gamma knife does it with radiation and no incision, but it won't work for all tumors or all patients. Sometimes, a neurosurgeon has no choice but to reach inside the skull with surgical tools. For years, this has required very large openings in the skull. Going in from above, surgeons use long metal retractors to pull the brain aside and hold it there. The risk? Permanent damage to this sensitive brain tissue.

Another approach goes by strikingly blunt, mechanistic monikers: facial disarticulation or facial disassembly. Surgeons peel skin back from most or all of the patient's face. They remove large chunks of the skull and the facial bones to access the skull base from beneath (which means the patient must later endure extensive reconstruction). The brain is not manipulated, but other complications associated with this approach can be devastating. It can damage nerves and structures related to facial expression, swallowing, and breathing.

When Kassam came to Pitt in 1997, surgeons like Carl Snyderman and fellow Pitt otolaryngologist Ricardo Carrau were learning to navigate the sinuses with endoscopes. They removed tumors and other malformations right up to the skull base. "We would stop at the bone that separates the sinuses from the brain," says Snyderman (Res '87, Fel '89). "We were working between the eyes and below the brain. That was what many people were doing, but then we started to take the tissue off the bone around the eye. We started to take the bone off below the brain but not go into the brain, and so we just slowly progressed."

Kassam, fresh from a neurosurgical residency in Ottawa, saw what they were doing and realized these head and neck surgeons were on the doorstep of minimally invasive skull base surgery. To figure out how to transform Kassam's vision into reality, the surgeons cleared their schedules one day and sat down in a room in UPMC Presbyterian to identify obstacles and plot a course for overcoming them. After several hours and numerous containers of takeout, they'd laid out a long series of steps—such as partnering with industry to design new instruments—that they knew would take years to accomplish. They agreed that progression would be slow and systematic, and that nobody would publish a word until they had 300 cases under their belts.

The approach from below was so foreign that the first task was to define the anatomy from that perspective. Surgeons were unable to look at the bottom of the skull and know which bump of bone hid the optic nerve or carotid arteries. These Pitt surgeons made it their business to map the skull base. As patients who could benefit from this approach arrived at the Department of Neurological Surgery, the team stepped cautiously, methodically, and gradually into the skull base. One of their first cases was a pregnant woman losing vision because of a grape-sized tumor compressing her optic nerve. They removed it through her nose. It took about two hours, and she regained her vision the next day.

"But we knew we hadn't changed the world," says Kassam, reviewing case histories in his office, "because we knew that if we went to neurosurgeons and said, 'We removed a grape from this space,' they would say, 'Come back when you have to take an orange out.' So here's an orange." He gestures to a brain scan on his computer screen. "It's a cylinder, and all this white stuff you see is engorged brain. Swollen. So if I have to manipulate this brain, this brain has a high likelihood of not functioning right when I'm done." Instead, he says, his team removed the tumor through the nose, bit by bit, without touching the brain.

A typical operation proceeds with Snyderman and Kassam on either side of the patient. They hold pistol-grip instruments; thin cables snake into the patient's nostrils. Snyderman, 49, an associate professor of otolaryngology and of neurological surgery, is slight of build with a narrow face. With angular spectacles perched between his surgical cap and mask, he seems the more professorial of the two. Kassam, at 10 years younger, could pass for an entrepreneur of the dot-com generation. He has the friendly intensity and demeanor of someone who just left grad school, framed his MBA, and took his company public all in the same week. The two are codirectors of Pitt's new Minimally Invasive Neurosurgical Center.

To reach a tumor resting on the skull base, the surgeons will drill through the base of the skull and land right on the tumor without manipulating the surrounding brain tissue, nerves, or arteries. Snyderman drives the endoscope and periodically taps a pedal with his foot to flush the lens clean with water. Kassam manipulates a device for suctioning blood and other fluids through one nostril; through the other, he controls an ultrasonic aspirator, which disrupts tissue and sucks it out all at once. An observer might momentarily forget the patient on the table, because both surgeons' eyes are glued to a video screen showing a patch of red flesh and the steel tips of Kassam's instruments. With the ultrasonic aspirator, Kassam strips away tumor, working outward until he can peel the last layer right off the brain.

Speaking at an annual congress of neurological surgeons in November 2003, Kassam let the cat out of the bag. He and his colleagues had performed 312 endoscopic approaches to the skull base in the previous five years. The initial reaction: denial. As Kassam described case after case of progressively more difficult and complex skull-base surgeries, the denial changed to anger. *Maybe you're doing it, but you shouldn't.*

"There has been a lot of resistance and skepticism from what we would consider the giants or the very senior people in this area of surgery," says Snyderman.

"You try to explain to a neurosurgeon that you took out the upper part of the spine through the nose, and they think you're certifiable at that point," quips Kassam. But this exact procedure, for an elderly woman whose spine was impaling her brain stem after years of spinal degeneration, was a natural extension of their endoscopic abilities. It was the safest way to proceed—an open procedure would have required splitting open the back of her mouth, potentially compromising her ability to breathe and swallow.

"I think the misconception is that we're just going in blindly and pulling out tumor without seeing the brain or nerves or blood vessels," says Snyderman. "There's nothing blind about what

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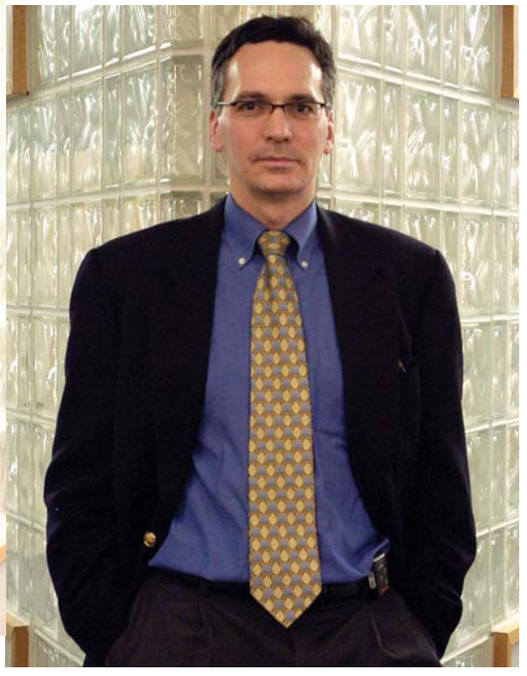

Amin Kassam (left) and Carl Snyderman

we're doing. We see everything."

"At first people would send their residents here to spend some time with us to find out what the gimmick was," says Kassam. "And the resident would go back and say, 'There's no gimmick. They are really doing it. They are doing this through the nose.'"

What was so hard to comprehend? Meet Sandra (not her real name), who was referred to them when she was a little slip of a girl, not yet 4. Sandra suffered nosebleeds so terrible they sent her parents rushing for bath towels, because tissues weren't enough. One night, she lost most of the blood in her body and landed in the ICU. The culprit: a mass of abnormal arteries and veins growing within her skull base. "Like a bag of worms hiding in a moth-eaten bone," was how Snyderman described this arteriovenous malformation (AVM). As it grew, it stole blood from her carotid arteries. Inevitably, it developed weak spots that periodically burst.

Typically, a tumor has a number of vessels supplying it with blood. Each can be clipped and cauterized to isolate the tumor for removal. (The notion of handling vessels in the skull base endoscopically set off alarms with Snyderman and Kassam's peers. *Eventually, you're going to get bleeding you can't control*, they'd say. *You'll be handcuffed, and the patient will die on the table.)* In Sandra's case, the entire mass consisted of blood vessels.

Some say that surgeons are conservative by nature. (The endoscope has revolutionized several areas of surgery, points out Snyderman, but it has always been met first with resistance.) Carrau, a professor of otolaryngology and of neurological surgery, is sympathetic to the initial reactions of some of his colleagues: "You have to understand what this is like for the people who have not done this before." He explains that most neurosurgeons are used to manipulating instruments through sizeable wounds—space enough to move their hands to clamp vessels or cut away tumors with traditional instruments. This work has never been easy, but "when you are going through the nose," says Carrau, "you have a limited scope and the instruments are very small. You have to change your technique. For someone who doesn't understand how that's done, and who's not familiar with the instruments, it would seem like an impossible task."

The Pitt team had always advanced cautiously, developing the tools and the skills to deal with aggressive bleeding before it even happened. But this little girl and her AVM made them especially wary. They'd worked in this area of the skull base, but not with so many blood vessels. They tried an open procedure first, removing a chunk of skull at her forehead to reach into the skull base without manipulating her brain. But she was so tiny that before the surgeons had made a significant dent in the AVM, she had already lost too much blood. They had no choice but to do it through the nose.

After a few weeks of recovery from the open procedure, Sandra went back to the OR. Snyderman (or "Dr. Spiderman," as Sandra sometimes calls him) began by inserting the endoscope in one tiny nostril. Through the other, he used forceps to take down the soft honeycomb-like sinuses and reveal the bone that hid the AVM. Kassam and Snyderman inserted a diamond drill to begin removing the bone. It whirred softly in the little girl's head as they watched the video screen. Her skull base was like Swiss cheese, with every hole filled with blood vessels. The finer ones sealed automatically with bone dust. For the larger vessels, Kassam worked with a suction device in one hand and an electro-coagulator in the other. As he cauterized each vessel, a bit of smoke went across the screen and into the suction. Sandra's blood pressure dropped as he suctioned blood away. He talked with the anesthesiologist as he proceeded. Kassam's end of the conversation essentially consisted of the question, *How much time have we got?*

They had enough time. The AVM was repaired in several stages, a few weeks apart. The before-and-after images are like aerial shots of a river during and after a 100-year flood. In one frame, the fluid of life flows everywhere and in every direction, inundating every available space. In the final image, it is restored to one central artery with an orderly series of tributaries. Sandra is doing well and is in first grade now.

Denial and anger are giving way to serious interest. A few other groups are now experimenting with the approach. In September, Pitt will host the first world congress of endoscopic skull-base surgery. The Pitt team teaches a course for surgeons three times a year—an astounding nine chairs or section chiefs came in the first year. But developing proficiency takes a long time, probably four years of additional training.

The most difficult problems to overcome can be the most basic. Sometimes, when Snyderman momentarily hands the scope to a resident or junior surgeon, the surgery cannot proceed because it's so difficult to maintain a view without getting in the way. Manipulating instruments that you only see on a video screen is "like playing Nintendo," notes Kassam. But it's not child's play. Kassam seems to have a preternatural ability to use both hands to navigate space that he cannot see—talents he traces back to his father, an automobile mechanic. His dad made him change spark plugs without using his right hand and oil filters without looking at them. This was the only way to become a good mechanic, from the elder Kassam's point of view. It also turned out to be great basic training for an endoscopic surgeon.

It's now approaching two years since these Pitt surgeons went public with the expanded endonasal approach. They are in high demand as surgeons, teachers, and now as private consultants, regularly rushing from appointment to appointment, from operating room to airport. "We're victims of our own success," Kassam says now, moments after being informed he's already running late for the airport, but he says it with a smile. ■