

2mm

*A Neurosurgeon's Journey Through the Microscopic World
Between Life and Death*

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Would I ever stop feeling like this?

My stomach churned with uneasiness as I scrubbed my hands at the sink. The rough nylon bristles scratched against my skin, the vibrant orange soap filling my nose with a sharp chemical smell. Methodically, I brushed every square inch, ensuring no spot was missed. Using a pick, I meticulously cleaned under each nail before scrubbing my arms up to the elbows once more. The rhythmic motion was almost meditative, yet beneath the surface, anxiety gnawed at me.

After three minutes, the sink automatically shut off. I dropped the sponge into the trash, letting the water drip from my hands down my arms, soaking my scrubs as I walked away from the sink. With the bottom of my foot, I kicked open the doors of the OR, entering backwards into the sterile room. The space buzzed with energy and excitement, a stark contrast to the anxiety inside me.

The anesthesiologist and nurse anesthetist engaged in a hushed conversation about medication dosages, their voices a soft backdrop to the hum of the ventilator. The patient lay on the OR table, fully ventilated and paralyzed, her body completely still and vulnerable. The surgical tech fussed over the orderliness and setup of her table, fastidiously arranging the surgical instruments, while my junior resident was finishing draping the patient. The OR nurse assisted him, their playful banter adding a fleeting glimpse of humanity to the otherwise cold clinical atmosphere.

I approached the surgical technician, my arms still dripping with water. She swiftly threw a blue towel over one of my hands. I carefully dried myself from fingertip to elbow before tossing the towel into the hamper. She then placed a gown over my arms, the fabric, cool and smooth against my damp skin, and threw the open collar around my shoulders.

The OR nurse moved behind me, fastening and tying the gown around my body with quick memorized movements. Two sterile gloves were placed over my gown sleeves, my hands emerging into the gloves without ever touching open air or the blue sterile gown surface. I tied the gown closed in the front, the sound of swift and decisive knot ties marking the final step of my readiness. I walked up to the anesthetized patient.

At this point, all I could see was the right side of the patient's head, hair clipped, and shielded by several layers of plastic with blue drapes covering her entire body. To an untrained eye, it would be impossible to recognize that beneath the drapes lay a human being. Only a piece of tissue was exposed, ready for surgery.

Her head was secured in Mayfield pinions which were three claw-like pins I had carefully inserted through her scalp into the outer layer of her skull. These were tightened to 60 pounds per square inch, enough to prevent any movement during surgery but not so tight that they would fracture her skull.

"Are we ready?" I asked the OR.

"We're ready for you when you are. She's received pre-op antibiotics," the anesthesiologist replied, his tone professional yet reassuring.

"Okay, keep her end tidal CO₂ below 30. I don't want her brain swelling as we open the skull."

"Got it," he responded promptly.

We performed a timeout, each member of the team moving in a synchronized ritual to ensure we were operating on the correct patient, the correct side of her head, and performing the correct procedure. The checklist was a lifeline, a safeguard against the chaos and easy mistakes that lurk in this high-stakes environment. We reviewed all necessary medications and protocols, the decisiveness of the situation settling over me like a heavy cloak..

Satisfied, it was time to make the incision.

I handed the scalpel to Max, my junior resident. "Make a curved incision along the entire right side of the patient's head."

He sliced through the scalp to the bone, the knife slipping through tissue effortlessly. The sound was unnervingly uniform, almost like unzipping a zipper. Together, we peeled the scalp and muscle away from the skull, like peeling the thick skin off a navel orange. The movements were automatic, honed by countless repetitions, yet each one felt significant in the moment.

We then took a drill and made careful holes through the skull, removing the bone, layer by layer. This work was rapid yet delicate. The drill needed to land perfectly in the 3 mm space between the skull and its fragile contents. Too deep, and we'd plunge into the brain; not deep enough, and we would be denied access to the intracranial contents of this woman's head. Having performed this procedure over six hundred times, I guided the junior resident, now in his third year. Once the holes were complete, we used a special router, called a craniotome, to

cut the skull between the holes creating a large segment of bone that could be lifted away from the brain.

“Keep the angle steady. Don’t catch the brain,” I instructed. My voice steady despite the adrenaline coursing through me.

We lifted the skull piece like removing the lid from a jar, exposing the dura mater, a thick connective tissue layer protecting the brain and separating it from the rest of the body. I confirmed with the anesthesiologist that the CO₂ levels were low enough. If her CO₂ was too high, the brain would swell once we opened the dura mater, leading to a disastrous situation.

“CO₂ levels are 28,” he reported.

“Good.”

With confirmation received, I carefully incised the dura with a scalpel, making single-cell-depth cuts until I could see the brain, careful not to damage it. The taut resistance of the tissue under the blade contrasted sharply with the smooth, fragile surface of the brain. Using telescopic glasses, my hands moved in a microscopically magnified world ensuring the accuracy of my incision. Creating a space between the dura mater and the brain, I slipped a small pair of scissors into the gap and cut a curved flap, exposing the patient’s brain.

Before me lay a familiar sight: a gyrated, opaque white, gelatinous organ with blood vessels weaving through its folds and undulations. The brain, delicate and vulnerable, yet unimaginably complex, housed everything that made this woman who she was; her personality, memories, intellect, emotions, relationships... All her love and hate, knowledge and beliefs, desires and fear were stored and encoded in this soft, gyrating tissue.

Yet, as beautiful as it was, something was amiss. I had seen countless brains in surgery and could discern the difference between healthy and diseased. This brain didn’t pulsate with each heartbeat; it seemed tense and congested. The capillaries were unnaturally purple, and the brain’s surface lacked its usual glossy sheen, appearing opaque and dull.

A week earlier, she had come into my clinic after a month of deterioration. She struggled to move the left side of her body, and her personality had withered away. Her husband complained that she no longer experienced joy or sadness; she had become lifeless and flat. Complex tasks became insurmountable, and she withdrew from the world, becoming distant from her relationships.

Basic memories, like her children’s names, eluded her, and each morning began with severe headaches and vomiting. A CT scan revealed a large tumor deep within her right brain.

An MRI confirmed the diagnosis, and I knew she needed urgent, well-planned surgery to remove the tumor that had taken root deep in her brain. After thorough discussions, the patient consented to the procedure. Now, she lay covered in drapes, her brain exposed to the sterile environment.

“Okay, give me the stealth wand,” I instructed the surgical technician. She handed me a probe resembling a small branching tree on one end and a pointer on the other. The probe had shiny diamond balls at its tips, reflecting light to an overhead camera that interfaced with our navigational computer system, which displayed the patient’s brain and tumor on a large screen. We were using a stereotactic navigation system: three points in space triangulating to one point within the brain. On the computer screen, a blue dot marked where I placed the pointer over her brain. We were still two centimeters away from the tumor.

The frontal lobe and the temporal lobe came together like the thumb and index finger fit together in a closed fist. The separation between these lobes formed a tight crevice called the Sylvian fissure. As I analyzed the navigational images, I could see a clear path through the Sylvian fissure to the heart of the tumor. This was our safest route.

“Let’s open the Sylvian fissure,” I directed.

Bringing in a large cantilevered microscope with 10x magnification, Max and I worked to release tiny microscopic adhesions between two brain lobes. The air was thick with concentration, the only sounds were the soft hum of the suction tubes and the rhythmic beeping of the patient’s pulse. As we freed these adhesions, fluid flowed from trapped spaces, and the brain began to relax, its tension easing under our careful hands. Soon, we removed the last adhesion, and the tumor came into view, pearly white and distinctly abnormal.

“That’s a big one,” Max observed, his voice tinged with awe.

“Yeah, six centimeters,” I replied, probing the tumor’s firmness with my sucker tip.

“I’m surprised the patient could accommodate a tumor this large.”

“It must have grown fairly slowly,” I said. “That’s the only way she could have survived something like this. But the MRI shows some abnormal changes now. It looks like it’s becoming more aggressive.”

The tumor was firm and unmovable with gentle manipulation. I would need to slowly and meticulously remove this tumor layer by layer, careful not to pull or push on the surrounding brain.

“Give me the ultrasonic aspirator,” I said.

The technician handed me a high-powered instrument the size of a large pen with a metal tip and a hose coming off its back end. A foot pedal was set at my feet and when I pushed the pedal the aspirator tip hummed with a high pitch vibration at ultrasonic speeds, all the while suctioning and irrigating sterile fluid around the tip. As I touched the tumor, it began to break up cell by cell, and suck up into the aspirator with relentless precision. In my other hand, I held a bipolar cautery, which was like large tweezers with electricity flowing between the tips. Anytime I encountered a small bleeding vessel feeding the tumor, I coagulated it by using the cautery; the sizzling and popping signaling the coagulation and destruction of the vessels.

Working slowly, I disintegrated the tumor with the aspirator while stopping bleeding vessels. Max gently retracted delicate brain areas and suctioned any blood or fluid accumulating in the cavity. Layer by layer, the tumor disappeared from existence. Under 10x magnification, hours passed as we meticulously removed the bulk of the tumor. The room seemed to shrink around us, and the OR faded into a distant hum. We were immersed in a microscopic world where our movements lived within millimeters and a centimeter became dangerously large.

The silence of our deliberation was broken when the attending physician entered the room. "How's it going, Dr. Kumar?"

"It's going okay, Dr. Donahue. We've got the majority of the tumor out. There's just this one section down here."

He peered over, his eyes scanning the exposed brain tumor. "Be careful with that part. It may be right on the carotid artery and optic nerve."

"Yeah, I will," I assured him.

"If there's any chance it's stuck to those structures, just leave it. We'll treat it with radiation later."

"Yes, sir," I replied, testifying to my own resolve to bring this woman out of her surgery uninjured.

He left, confident I was in control. I brought in the stereotactic guided probe again, placing the tip on the last bit of tumor.

"Oh, it's not even close to the carotid," Max noted, a hint of relief in his voice. "Look, the optic nerve and the carotid are pretty far away."

“Pretty far is relative in neurosurgery,” I mused. A half centimeter was a light year in a surgery like this.

Checking the screen, I saw that the tumor chunk was about a centimeter from the carotid artery and optic nerve. It should be safe to remove. I requested a pituitary rongeur; a small, jaw-like tool on a scissor-like handle. Delicately guiding it into the deep cavity, I grabbed a piece of the tumor tissue. A small flush of blood surfaced as I applied pressure.

“Doesn’t feel right,” I said, as my intuition signalled danger.

“Why?” Max asked. “It should be safe to take.”

“I need to check something. Hold on.” I asked for a micro-dissector and carefully dissected around the tissue. Slowly, I lifted it...

The carotid artery and optic nerve directly beneath\! If I had removed it with the pituitary, I would have avulsed the carotid artery, a fatal and devastating injury.

“Oh my God,” Max exclaimed. “Why is that there?”

“The brain’s shifted,” I explained, my voice steady despite the rush of adrenaline. “It’s not in the same place as on our stereotactic scan. We’ve removed so much tumor that the brain is starting to settle back into its normal position.”

Just two millimeters of error here would have been disastrous.

Carefully, I dissected the tissue away from the carotid artery and optic nerve, removing it safely. The tumor had been fully resected.

I stopped any minor bleeding capillaries and veins, the faint scent of anesthetic gas mingling with the burnt smell of blood, and washed out the cavity thoroughly with sterile saline. I then instructed Max to close the dura mater, reattach the skull bone using titanium plates, and stitch the scalp back together.

I tore off my gown, the fabric whipping against my skin, and walked out of the OR. A wave of relief washed over me as I reflected on another high-risk surgery without complication... Another patient granted a new chance at a normal life.

With only weeks left until graduation and the completion of my neurosurgical training, I paused to look back on the seven-year journey that had led me to this moment. It had been an impossibly arduous path, riddled with grueling work, sleepless nights, successes and failures, happiness and tears. The stakes were high, and the margins for error had been minuscule. Precise judgments and microscopic hand movements walked the fine line between a recovered patient and a devastated life.

There were years when I barely saw my children. Days when I questioned my choice to become a neurosurgeon, feeling foolish for continuing. Yet, there were also days when I felt on top of the world, fascinated beyond belief by the privilege of performing such a precious task.

This is the story of my journey... A journey of transformation and discovery, of success and tragedy, of peril and deliverance. It's the story of how a naive young man would become a steward of the human nervous system, where razor-thin margins divided disaster from salvation, and where two millimeters could mean the difference between life and death.

That is where it begins.

The book follows the seven years that came after: the patients I lost, the ones I saved, and what the work costs the person doing it.

It is finished. I will email you the day pre-orders open.

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