Beyond the bullet: Surviving a shot to the head carries host of challenges

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The spectral images, reproduced in neurosurgery journals and textbooks, could be captioned "Beauty and the Beast." Captured by X-ray and CT scan, the human brain is pierced by a bullet, nail, pool cue or chunk of razor-sharp debris. The intruding object has ripped a jagged vortex of destruction through the brain's gelatinous lobes and forged an even wider path of quivering shock.

If the projectile came in hard and fast, shards of broken skull will be scattered through the delicate tissue. The bullet might have ricocheted off bone and tumbled wildly in the cavity, bursting blood vessels and carving uneven holes where, only moments before, healthy brain cells had hummed.

Such havoc, you would think, would put an abrupt end to the brain's rhythmic buzz of activity and extinguish the life defined by its complex inner workings.

But - as the awakening of Rep. Gabrielle Giffords has demonstrated these last weeks - the human brain can be resilient, capable of withstanding brutish damage and then masterminding its reconstruction.

"I have seen every foreign body in the world pass through the brain, and I never cease to be amazed that some seem to survive and do amazingly well," said Dr. Ian Armstrong, a Century City, Calif., neurosurgeon, shortly after Giffords was shot.

Make no mistake: Bullets usually kill when they enter the brain. The U.S. Centers for Disease Control and Prevention estimates that in 90 percent of brain injuries that stem from firearms, the patient dies. Of the lucky 1 in 10, virtually all are thought to live with persistent disabilities.

In the last 15 years, however, better treatments have greatly improved the odds of survival. "In Iraq, we were fooled many times," said Duke University neurosurgeon Gerald Grant, who was an Air Force physician at Joint Base Balad in that country. Patients whose scans showed that shrapnel had crossed between the brain's hemispheres or cut a wide swath of destruction - injuries long thought to be a swift sentence of death - would often live.

But the result, as Giffords may yet show, is almost always a person profoundly changed by the injury.

As many as half of those who have had penetrating brain injury will suffer epileptic seizures and will have a higher risk of them for the rest of their lives, experts say.

Because these injuries often leave a victim fully conscious during and immediately after, many will retain vivid memories of the horror and suffer flashbacks, nightmares, anxiety and withdrawal, the hallmarks of post-traumatic stress disorder.

Vietnam veterans with a penetrating brain injury have shown steeper cognitive decline than that of their uninjured peers - apparently an accelerated version of normal age-related decline.

Beyond those broad strokes, the exact consequences of a penetrating brain injury depend heavily on where and at what speed the foreign body penetrated the skull.

"There are some parts of the brain that have high real estate value," says Dr. Jam Ghajar, president of the Brain Trauma Foundation and clinical professor of neurological surgery at Weill Cornell Medical College in New York City. "If you go into the brainstem, or a millimeter to the right or left, you can have massive disruption and almost certain death. You go into the frontal lobe and you have a lot more room for error."

The brain is a marvel of redundancy, parallel networks and interlocking message centers that might, with time, rewire around obstacles. But many clusters have precise functions - governing word access or face recognition, or processing vision, hearing and smell. Damage to those can cause specific, maybe permanent, impairments.

Damage to deep brain structures such as the amygdala or the hypothalamus will likely disturb a victim's ability to fully form, retain and retrieve memories that are freighted with emotion. Such impairments can wreak havoc on relationships and day-to-day functioning.

Some damage is subtler still. When a penetrating object has stretched or torn some tissue, including the connective "white matter" that forms bridges among brain regions, problems of attention, memory and social processing make it tough to navigate the demands of work, high-level thinking or new social situations.

Damage to the frontal lobes - common in traumatic brain injury because they lie right behind the forehead - can disturb a person's ability to formulate plans, read or respond to social cues, and suppress the impulse to do or say things that might be socially inappropriate.

Such impairments - labored speech, flat emotion, an odd social manner, an inability to make and carry out a plan - often linger. Those symptoms plague many of the estimated 5.3 million Americans who live with the

persistent consequences of brain trauma. Little wonder that brain injury is often called the silent epidemic.

After the threat of death has passed, the challenge of regaining lost abilities - and of adjusting to life without others - is where the power of human resilience and inventiveness really inspires awe and humility, say those who have studied such injuries or witnessed the fallout up close.

"It's been a heartbreaking and inspiring thing to see," said Daniel Gross, whose younger brother Matthew, 41, was shot through the head 14 years ago by a gunman on the observation deck of New York's Empire State Building. After a week in a coma, Matthew first struggled to piece sentences together. Fully articulate after years of rehabilitation, he wrestles now with more subtle conventions of tactful conversation - the result of the bullet's passage through the frontal lobes on both sides of his brain.

Jordan Grafman, an expert on the long-term effects of penetrating trauma, says the survivors he has studied are remarkable not only for having survived but also for their determination to adapt and grow beyond their losses.

"At least half of our guys are working in full-time jobs and have families," says Grafman, director of research on brain injury at the Kessler Foundation in West Orange, N.J. "While people are uniformly left with impairments that are significant, they often show a tremendous ability to recover and really live productive and meaningful lives."

A patient's long-term recovery is profoundly affected by the person he or she was before the injury, Grafman says: A person who was clever, socially adept and intellectually engaged before the injury is likely to recover more lost capability than a person who had less mental horsepower or fewer social resources - friends, school, work, hobbies.

Grafman's conclusion comes from a unique cache of data: a decades-long study that has tracked some 200 Vietnam veterans who survived penetrating brain injury. The military's practice of testing troops for mental fitness gave researchers a standard gauge of intelligence and ability on each person that predated his injury. That provided a basis for measuring changes in a survivor's cognitive function in the decades after.

Ingoing scores on the armed forces' qualifying test have been the best predictor of a brain injury survivor's recovery from impairment, Grafman says. Now the study has begun to assess the influence of caregivers' styles - whether they are demanding or lenient, pushy or reserved, socially linked or more withdrawn.

Ironically, for those best equipped to rebuild their lives - people who, pre-injury, were exceptionally bright and highly motivated - the injury can pack a cruel surprise. Many grasp the extent of their impairments and are impatient to regain lost abilities that may never come back or that return at an agonizing snail's pace. Such survivors, Grafman says, are more vulnerable to depression and anxiety, which can impede progress and make life a misery.

As the nation tracks the recovery of Giffords, some worry about how the weight of expectations - and the Arizona Democrat's own formidable intelligence and drive - will affect her ability to overcome or adapt to the impairments likely to come with her injury.

One of them is Jackie Nink Pflug, who survived a bullet to her head at point-blank range during the 1985 hijacking of an EgyptAir flight from Athens to Cairo.

During years of painstaking recovery, Pflug relearned how to find her words, read a book, count money and navigate the world with seizures, excruciating headaches, a narrow field of vision, unreliable memory and

the loss of hearing in one ear.

Asked what she would tell Giffords, Pflug urges her, above all, to "be patient with yourself."

In the first several years, she says, she sometimes "didn't know where the brain injury ended and the depression began." But rather than slow down, she pushed harder. "I wanted to do better, and my brain wasn't always ready for it."

Now, she says, "I'm just really good to myself." Giffords should be too, she adds.

"Even the littlest things, have a party about it."