Chapter 1
General Concepts About Adult Brain Surgery

Are there too many surgical operations being performed?

There is reason to believe that the answer is “yes,” not just for adult brain surgery, but across the board. For example, there is evidence that some 30% of Medicare patients (American patients mostly over age 65) have at least one surgery in their last year of life [1], and studies have also shown that surgery on frail, elderly patients rarely helps them live better or longer lives [2]. Now one could argue that it would be fairly difficult to test this general premise on the population as a whole. One way would be to stop most, if not all surgery that was being done, and see if it made a difference, but no one would ever agree to such an experiment. But is not that exactly what happened during the 2020 COVID-19 pandemic? Numerous areas throughout America and the world shut down their hospitals for most surgical procedures (and for most standard hospitalizations) for several months straight. The results? The harm? The devastation from people missing their critically needed surgery? The truth is that we did not really see that much harm at all. Of course, there were individual cases presented of the consequences of the missed surgery. But, as a whole, the public outcry for their surgery was really pretty muted. That is not to say that some surgery is not beneficial, but it certainly strongly suggests that a lot of the surgery performed is not really as critical and beneficial (or as urgent) as many people think it is.

As surgeons, we need to start asking with each operation: “Was that operation really absolutely necessary and unavoidable?” and “Was an alternative, less invasive, or nonoperative treatment a reasonable option?”

Why Adult Brain Surgery Is Different

One could argue that the study of adult brain surgery is, in fact, no different than the study of anything else. I would disagree for a few reasons. First, adult brain surgery is arguably one of the highest risk things a person can have done to themselves.

M. H. Brisman, *Put Down the Knife*,
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Second, the risks undertaken in adult brain surgery are undertaken for purely therapeutic purposes. That is, there may be many "risky" things people do, but they are doing them for the enjoyment, or adrenaline rush, or lack of awareness, or some other reason. People accept the risks of adult brain surgery, knowing that there are serious risks, for the sole purpose of achieving some significant improvement in the quality of their lives, or the length of their lives, or both. Third, adult brain surgery, due to transformative advances in just the past 20 years, can be performed with a degree of safety that has not been present before, especially if one considers minimally invasive adult brain surgery alternatives. Fourth, medical advances have also progressed dramatically, such that non-surgical alternatives are often at least as good as surgery.

Major Minimally Invasive Brain Surgery Interventions

The two major categories of minimally invasive brain surgery that have fundamentally changed the way brain surgery is practiced are (1) stereotactic radiosurgery and (2) endovascular neurosurgery. The ramifications of these two techniques on modern adult brain surgery cannot be overstated.

Stereotactic radiosurgery is a super-focused radiation technique that usually involves gamma rays (such as with a Gamma Knife machine) or x-rays (such as with specially modified Linear Accelerators or "LINACs"). This technique can be used for treating brain tumors (both malignant and benign), brain vascular malformations (including arteriovenous malformations, arteriovenous fistulae, and cavernous malformations), and various functional disorders (such as trigeminal neuralgia, glossopharyngeal neuralgia, and refractory tremor).

Endovascular brain surgery is a catheter based technique that can be used for diagnostic cerebral angiography, brain aneurysm coiling and stenting, brain arteriovenous malformation and arteriovenous fistulae embolization, mechanical thrombectomy for stroke, embolization for epidural hematoma and chronic subdural hematoma, pre-resection tumor embolization, carotid stenting, intra-arterial medicine applications for cerebral artery vasospasm, and carotid or vertebral artery sacrifice (for some rare giant aneurysms).

While there are other specialists besides neurosurgeons who will perform these techniques, such as radiation oncologists for stereotactic radiosurgery and radiologists and neurologists for endovascular brain procedures, it is critical for neurosurgeons to remain fully active participants in these two fields. For example, the neurosurgeon who performs radiosurgery should be deciding independently which patients to treat with this technique and exactly how to treat them (obviously with confirmation/concurrence from the radiation oncologist). Furthermore, it is best for the neurosurgeon who specializes in these fields to be fully adept at the "open" brain surgery procedures for the diseases treated by these "minimally invasive" techniques. By fully understanding both the less invasive and more invasive brain surgery techniques, the neurosurgeon can help guide the patient to the optimal choice of treatment.

What Is the Purpose of Adult Brain Surgery?

While the answer may seem obvious, it is surprisingly not obvious to many. The purpose of adult brain surgery should be (1) to "significantly" increase the length of a person's life that is enjoyed at a certain high quality that cannot be achieved by "non-surgical" measures; (2) to "significantly" increase the quality of life that a person enjoys for the same length of time, which cannot be achieved by non-surgical measures; or (3) to "significantly" increase both the length of a person's good quality life and the degree of quality of a person's life, which cannot be achieved by non-surgical measures. As such, these are the only relevant "primary endpoints" for a study that purports to justify any brain operation.

Now one could argue about what constitutes a "significant" increase in life or a "significant" improvement in life, but we should generally agree that this is the purpose of adult brain surgery. Lengthening a life by a few weeks would hardly seem to justify brain surgery; extending by 5 years the life of someone who has a poor and miserable quality of life would also seem to be of dubious value. Furthermore, the burden of proof should be on the brain surgeon to establish that the proposed procedure is likely to dramatically improve length of life, quality of life, or both, and in a manner that could not otherwise be achieved.

General Neurosurgical Insights

While there are obviously many general points to be made on surgery and neurosurgery, I will mention only a few.

- *Primum non nocere*—first do no harm (an ancient concept in medicine).
- Good surgeons know how to operate, better ones when to operate, and the best when not to operate [3].
- If there is a question about seeing the patient, see the patient. If there is a question about getting a CT scan, get the CT scan. If there is a question about putting in a ventriculostomy, put in the ventriculostomy. And always be nice to the nurses (Dr. Ronald Brisman).
- Incidental findings ("incidentalomas") are usually benign and usually best left alone or observed.
- Often the only surgery that was really necessary was the surgery to fix a complication from the first operation.
- The best way to minimize the length of a patient's hospital stay (other than selecting the least invasive treatment option) is to tell the patient when they are expected to be discharged. For example, I will tell my microvascular decompression and transsphenoidal patients that they will need to stay overnight in the hospital. This has helped tremendously in having these patients agreeable to being discharged the day after surgery.

- Very few people really need brain surgery, and those who do will usually be best served with a minimally invasive procedure. Said another way, "the best operation is usually no operation," and "less is usually much more" when it comes to adult brain surgery.
- If a medical intervention or operation is considered to be "controversial," there is a good chance that the medical intervention or operation is not going to be helpful.
- The best way to avoid a serious complication is to limit surgery, particularly in eloquent or high-risk areas, unless absolutely necessary.
- The more complicated and riskier an operation is, the less likely it is to be helpful.
- Surgeons often completely underestimate the importance of the appropriate "timing" of surgery. Many operations that are helpful will only be so if performed in a very specific time frame. For example, sometimes a brain operation must be performed fairly quickly, and often the more significant the symptoms and the more rapidly the symptoms have developed, the more quickly surgery will need to be performed to be beneficial. Conversely, sometimes the surgeon must wait before performing an operation, either because time is needed for proper medical clearance and optimization, because a further work-up is needed, or because one must allow anticoagulants to be fully eliminated from a patient's system.
- A surgeon should not aggressively dissect tumors, or other things, that are stuck to cranial nerves or critical blood vessels. If the abnormality is benign, it does not matter, and if the abnormality is malignant, it also does not matter. Residual abnormalities can usually be treated in other ways, such as with stereotactic radiosurgery or standard radiation therapy.
- If an inexperienced person has a complication, the most likely cause of the complication is the person's inexperience.
- The longer the list of patient complaints, the less likely the problems can be fixed with surgery.
- Having a surgical trainee (resident or fellow) perform part of an operation necessarily increases the risk of that operation, particularly if the trainee is not being directly supervised by an attending surgeon.
- A surgeon should never be the only one to know bad news. If there is a serious medical issue, or serious diagnosis, or any other serious problem, it is critical that it be communicated promptly to the appropriate people, whether that is the patient, family member, chief resident, attending physician, chief of service, nursing supervisor, hospital administrator etc. This is a particularly critical concept for physicians in training, like residents and fellows. Prompt communication of serious matters that arise in complex systems (like hospitals) is critical for trust and safety.
- The best surgical outcomes occur when the surgery is performed by an experienced attending surgeon, with an experienced operating room team, during regular weekday hours.
- After a neurosurgical residency or fellowship, neurosurgeons still require a significant amount of proctoring and oversight from more experienced neurosur-

geons. Many more errors are made by neurosurgeons in the first few years out of training than subsequently.
- Surgeons cannot optimize their performance if they do not actively engage in the non-surgical management of potential surgical patients and the non-surgical management of patients after surgery. Furthermore, lengthy follow-up is often needed for the surgeon to fully appreciate their own successes and failures. The full extent of surgical benefits and complications is often not appreciated for a long time.
- The base of a scalp flap should be at least 1.5× as long as the depth. This is important to maintain proper vascularization to the flap and to avoid the risk of ischemia to the deepest portion of the flap.
- Fibrin sealants are associated with an increased risk of complications [4], so they should only be used if absolutely necessary.
- SURGIFLO should not be used near the ventricles as intraventricular application can cause hydrocephalus.
- Great caution should be used in manipulating a patient's neck once they are under anesthesia. Many people, particularly older patients, have underlying cervical spine disease, and aggressive manipulation can cause a spinal cord injury.
- Hyponatremia in patients with acute brain disease is usually caused by cerebral salt wasting syndrome (and is associated with euvolemia or hypovolemia). Sodium replacement (oral or intravenous) along with gentle hydration should be used for gradual correction. Blood sodium level correction must be gradual to avoid causing central pontine myelinolysis.
- A good surgeon is a humanitarian who cares not only about what happens to their own patients, but to other people as well. They have great compassion, and they have a great fund of knowledge. They keep up to date on advances in their field, and they have good judgment.
- A good surgeon never forgets their worst complications.

Who Should Be the "Captain of the Ship"?

The phrase "captain of the ship" is often invoked in the medical setting, with the question being, who should be the ultimate decision maker for a given medical decision.

The most appropriate person to make decisions about adult brain surgery is the brain surgeon. Obviously, one cannot proceed with any decision to operate or not operate without support of the patient and others, but ultimately, the person who should have the most insight into the issue is the surgeon.

It is not reasonable to suggest that some other physician should be making this decision. It is even less reasonable to suggest that medical extenders, like nurse practitioners or physician assistants, should independently be making any such decisions (for these or any other major medical issue).

A real threat to such proper decision-making is the decreasing ability of the neurosurgeon to function as part of an independent private practice. While it is not critical that all neurosurgeons work in a private practice for them to be able to make the best decisions for their patients, it is necessary that such practice be a viable option. Absent this, brain surgeons, like other physicians, will just feel compelled to make decisions that please their employers.

Four General Classifications of Brain Surgery

One might consider breaking down brain surgery procedures into four types of categories as listed below:

1. Clearly indicated, performed with few complications;
2. Clearly indicated, performed with high complications;
3. Not so clearly indicated, performed with few complications;
4. Not so clearly indicated, performed with high complications.

Category 1 procedures, ideally, would make up most of the adult brain surgery procedures that are performed. These are clearly indicated procedures that are performed well with few complications. Unfortunately, I would contend that there are many procedures performed that would fit into categories 2, 3, and 4.

Category 2 procedures will often be justified with the argument that the case was clearly indicated, and complications necessarily happen at a certain rate, without really questioning whether the surgeon or circumstances of the surgery might have contributed in some way to the complications that occurred and suboptimal outcome.

Category 3 cases are often deemed acceptable because doctors and hospitals are under pressure to produce a certain surgical case volume, so, even if the surgical indications were somewhat questionable, the case will be tolerated due to the low rate of complications and side effects.

Category 4 cases will also often be overlooked if the patient was likely to do poorly anyway. Category 4 cases performed in otherwise young and healthy people are least likely to be tolerated but may still get a pass from other doctors and administrators if the frequency of these events is not too high for that particular surgeon or that particular hospital.

The Major Flaw in How Most Neurosurgeons View Adult Brain Surgery

There are many misconceptions that neurosurgeons and others currently have in regard to adult brain surgery, but they all come down to the following main error: There is a consistent gross underestimation of the risks of adult brain surgery, and there is a consistent gross overestimation of the benefits of adult brain surgery. This single error leads to many "open" procedures, generally craniotomies, being performed, when a less invasive alternative or no procedure at all would have been preferable and yielded better results.

A recent study [5] gives some sense that this conclusion is correct. Their prospective study of neurosurgery patients included 2258 patients undergoing brain surgery. Of these, some 24% had complications, of which 57% were graded as "severe." And even this number of complications is likely dramatically understated as various major categories of complication were not even considered, like pain, anxiety, depression, subtle permanent deficits, and inability to return to work. Furthermore, there is real evidence that hospital stays are much riskier than most people realize. For example, a recent large study of 2809 consecutive hospital admissions found at least one adverse event in 23.6% of admissions, with about a third of the adverse events being "serious" [6].

I will deal separately with many different standard adult brain surgery topics, but it is important to first understand what might be the sources of confusion in general, before I discuss each topic in particular. These sources of error are numerous.