Proper and safe application of a three-point rigid cranial fixation device provides immobilization of the skull in a secure fashion without interfering with incision. It begins with firm placement of the two-point swivel arm before engaging a contralateral single pin. The application avoids critical neurovascular structures (superficial temporal artery, supraorbital artery and nerve, occipital artery), areas of thin bone (temporal squamosa), and regions with underlying venous structures (transverse and sigmoid sinuses).
Three-point rigid cranial fixation is central to a vast array of neurosurgical procedures, including cranial and cervical spine surgery. Accurate and safe fixation of the cranium is essential for patient positioning, optimal surgical conditions that allow for good surgical outcomes, and avoidance of complications and patient injury from cranial movement during surgery. Surgical anecdotal lore and the medical literature detail reports of positioning mishaps, including intraoperative head movement from improper pin placement and epidural hematomas from pin site skull fractures (Vitali and Steinbok 2008). An essential goal of neurosurgical training is to educate residents in the accurate and safe use of cranial fixation devices with the goal of an operative experience that is efficient, safe and facilitates good patient outcomes.

Three-point cranial fixation pin placement is dependent on the surgical procedure to be undertaken, pathological condition to be treated, desired patient position, patient body habitus, and the

Key points
• “Falling into the pins”
• Avoid neurovascular structures
• Pin pressure for adults 60 to 80 lbs
• Pin pressure for children 30 to 40 lbs
• Avoid using pins in children less than 3 years of age

Figure 1. Diagramatic representation of the head “falling into the pins”. Placement of the single pin and at least one of the double pins below the equator insures that this criterion is met. The key is to imagine the cranial equator as it presents itself in a specific head position, as dictated by the lesion to be approached and corresponding patient position.
specific technologies that will be used during the procedure. The human cranium has multiple safe zones where pins under pressure are unlikely to create intracranial injury. Likewise, multiple danger zones exist, and placing pins in these locations substantially increases the risk of causing injury to neurovascular structures overlying or deep to the skull. The accompanying illustrations depict accurate and safe pin placement for pterional, temporal, bifrontal, and prone craniotomies, including descriptions of safe and danger cranium zones.

A key principle in placing a three-point cranial fixation device is the concept of the head “falling into the pins”, which means the cranium is held safe in two regards: 1) tightness of the pins, and 2) spatial positioning of the pins relative to the cranial equator and gravity. This is shown schematically in Figure 1, and each anatomical illustration shows how this applies in the surgical suite. Each anatomic illustration indicates where to place the pins to ensure that two of the three pins are below the cranial equator, insuring that the cranium will be held safely even if the pins were to be less tight than optimal. The cranial equator changes from one operative approach and corresponding patient position to the next. By keeping this principle in mind, however, the surgeon ensures that the cranium will fall into the pins with the aid of gravity, even if reduced pressure is supplied by the fixation device or the fixation device slips or is loosened. This reduces the risk of injury and potential morbidity to the patient.

Proper application of the three-point cranial fixation device is critical to providing immobilization of the skull, ensuring secure cranial positioning and avoiding cranial movement during the procedure. The method for applying the fixation device begins with firm placement of the two-point swivel arm, then engagement of the contralateral single pin. Placement of these pins requires being mindful of critical neurovascular structures, including the superficial temporal artery, supraorbital artery and nerve, and the occipital artery. Other important areas to avoid include areas of thin bone, such as the temporal squamosa, and skull overlying intracranial venous structures, including the superior sagittal, the transverse, and the sigmoid sinuses. All of these principles are communicated by the illustrations.

Even with perfect pin placement, complications may arise. Often this occurs following improper application of pin tension. In an adult with a normal skull, the appropriate tension is 60 to 80 lbs; in a child, however, this amount of tension may cause a depressed skull fracture and epidural hematoma so the tension should not exceed 30 to 40 lbs (Greenberg 2010) (Vitali and Steinbok 2008). Pins use is often discouraged when operating on children less than 3 years of age.
For the bifrontal approach, care must be taken to ensure that all three pins are placed below the cranial equator (Figure 2), which can be approximated by position of the ears but must be confirmed on each individual patient. One double pin is placed on the mastoid process while the other is placed superiorly and toward midline. The single pin is placed superior and posterior to the pinna of the contralateral ear. Placing the pins in this manner avoids the hazard zones of the thin squamous temporal bone and the venous sinus system. Consideration should be made of the risk of causing an epidural hematoma over the speech centers of the left hemisphere by fracturing the thin temporal squamosa. Some surgeons prefer to always place the single pin on the right side of the cranium to lessen this risk, although if placed correctly the single pin is at the posterior margin of the temporal fossa and has lower risk of causing a skull fracture than if incorrectly placed more anteriorly.

Figure 2.
Bifrontal approach. Purple indicates site for single pin while green indicates sites for double pins. The surgeon must be careful to place all three pins below the cranial equator and away from neurovascular danger zones, as shown. Placement of the pins as shown here will allow the cranium to fall into the pins. Some surgeons prefer to always place the single pin on the right side of the cranium to reduce risk to the speech centers, although if placed correctly the single pin is at the posterior margin of the temporal fossa and has lower risk of causing a skull fracture.
When setting up for a pterional approach (Figure 3), the goal of pin placement is to have the pterion ultimately facing upward when the patient is in the final position. The surgeon identifies the cranial equator and places two pins at or below this line. Double pins are placed such that one pin is just superior and lateral to the occipital protuberance, below the cranial equator, while the other pin is on the mastoid process ipsilateral to the side of surgical approach. The single pin should be superior to the temporal fossa (contralateral to the side of surgical approach) and just posterior to a coronal section that passes through the lateral canthus of the eye. These pin locations avoid hazard zones that include the supraorbital neurovascular structures (single pin placed lateral to these) and venous sinus structures posteriorly.

Figure 3.
Pterional approach. The goal is to have the pterion facing upward, toward the ceiling of the operative theatre, when the patient is in final position. The surgeon identifies the cranial equator and places two pins at or below this line. Purple indicates placement of the single pin, green indicates placement of the double pins. These pin locations avoid danger zones that include the supraorbital nerve (single pin placed lateral to this nerve) and posterior venous and arterial structures.
For the middle fossa approach (Figure 4), pins are placed such that the double pins are superior the occipital protuberance, which indicates the torcular herophili, and on either side of the superior sagittal sinus and superior to the transverse sinuses. The single pin should be located at or near midline several centimeters above the nasion. This avoids the bilateral supraorbital neurovascular structures. By placing the pins in these locations, the surgeon is sure to place two pins at or below the cranial equator and thus the head will fall into the pins. Secondly, these pin locations avoid hazard zones that include the supraorbital neurovascular structures and the venous sinuses posteriorly.

**Figure 4.** Middle fossa approach. Purple indicates placement for single pin, which should be located at or near midline several centimeters above the nasion. Green indicates placement of double pins, which should be placed superior to the occipital protuberance. These pin placements avoid danger zones of the bilateral supraorbital nerve, the torcular herophili, the superior sagittal sinus, and the bilateral transverse sinuses. By placing the pins in these locations the surgeon is sure to place two pins below the cranial equator and thus the head will fall into the pins.
A prone position is used in many operations, including posterior fossa and skull base procedures as well as cervical spine procedures. When preparing a patient for the prone position (Figure 5), the double pins are placed such that one pin is posterior and superior to the pinna of the ear while the other pin is anterior in relation to the temporal fossa, and should be at or near the margin of this fossa. The single pin is placed superior to the pinna of the contralateral ear at the margin of the temporal fossa. These pin locations avoid the hazard zone of the temporal fossa, the floor of which is the thin squamous temporal bone that if violated can result in epidural hematoma or other intracranial injury. The single pin and the anterior pin of the double arm provide the bulk of support to the head by being below the cranial equator. Consideration must be made of the risk of causing an epidural hematoma over the speech centers of the left hemisphere. If not constrained by other operative considerations, some surgeons prefer to always place the single pin on the right side to reduce this risk, although this risk can never be completely eliminated.

**Figure 5.**
Prone position. Purple indicates site for single pin while green indicates sites for double pins. In this arrangement the single pin and the anterior pin of the double arm provide the bulk of head support, and this pair must be placed below the cranial equator as it presents with the patient in the prone position. Some surgeons prefer to always place the single pin on the right side of the cranium to reduce risk to the speech centers.

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