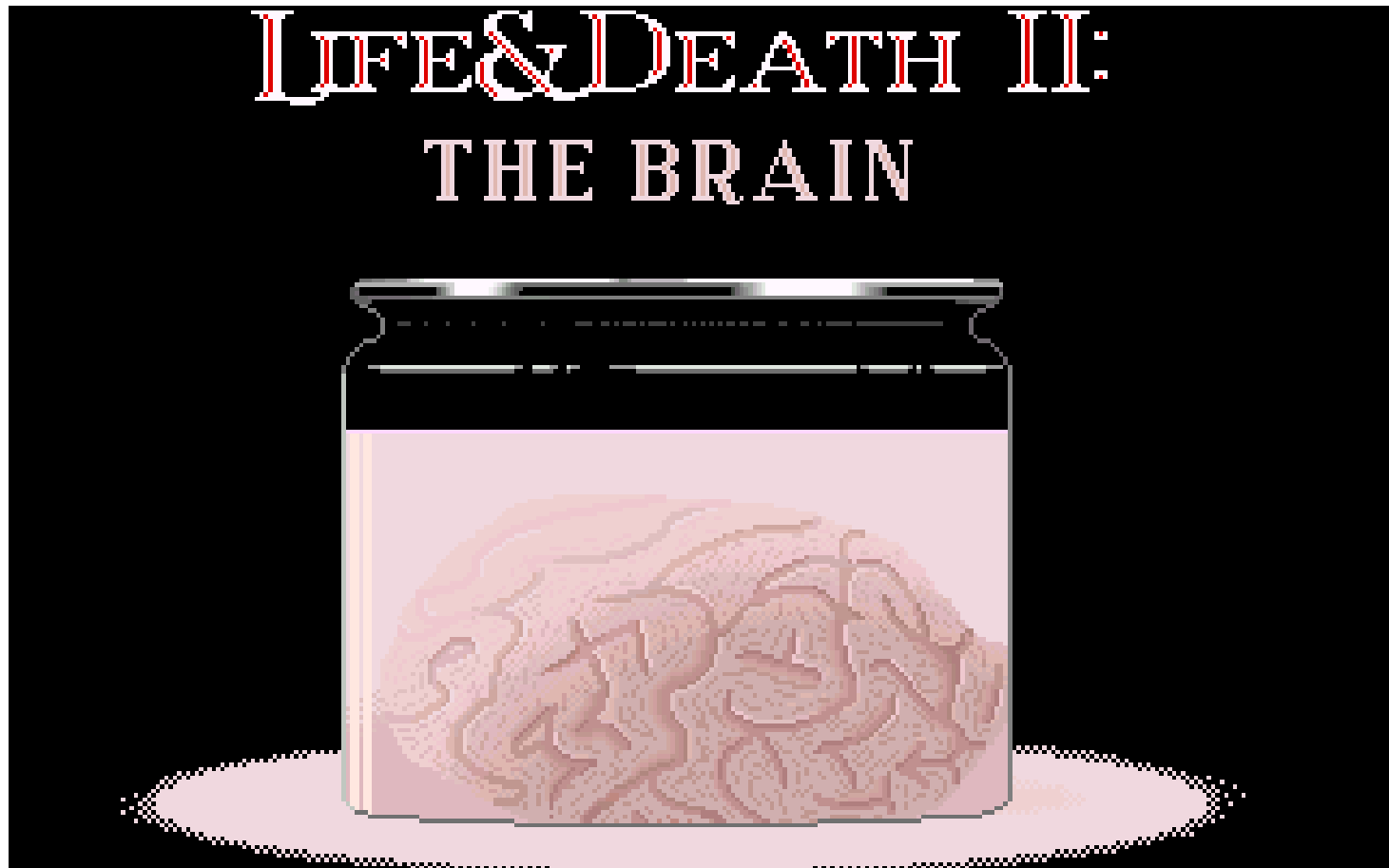


# Visuals from Life and Death II: The Brain

**NOTE: THIS IS ONLY FOR A COMPUTER GAME!!! NOT FOR REAL LIFE SURGERY!!!**

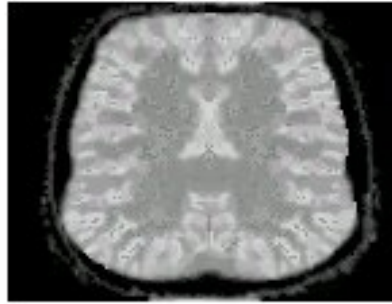


Training Aids for Budding Brain Surgeons

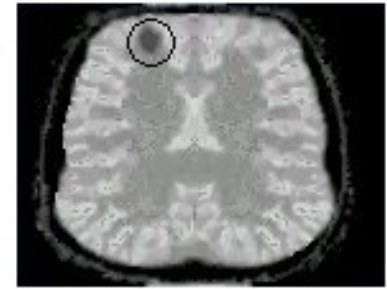
By **The Saccade**

# Diagnostic Techniques: Magnetic Resonance Imaging (MRI)

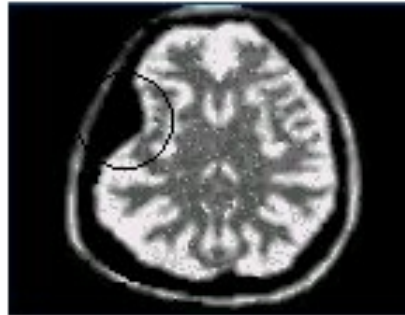
**This is a normal MRI scan. Note the absence of distinguishing abnormalities.**



**This patient has an aneurysm. Note the dark spot in the marked area which shows where the aneurysm occurs.**



**This patient has a subdural hematoma. Note the dark region where blood has pooled and coagulated in the marked area.**



**This patient has an infarction. Note the marked area showing dead brain tissue.**



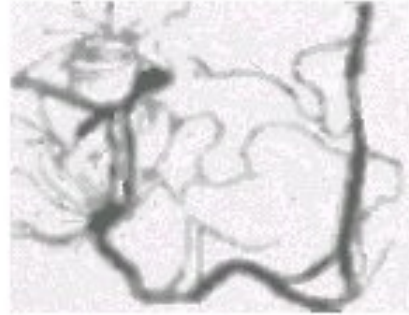
**This patient has a brain tumor. Note the marked area showing the abnormal growth.**



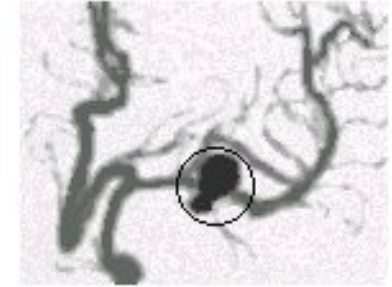
MRI cannot be used for patients with cardiac devices (pacemakers).

# Diagnostic Techniques: Angiogram

**This is a normal angiogram. Note the spacing of the blood vessels and the absence of any abnormalities.**



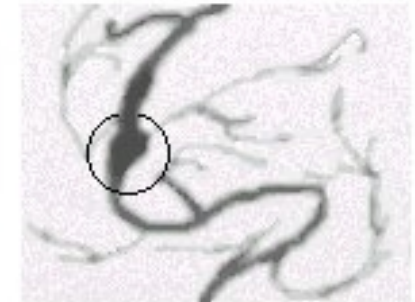
**This patient has an aneurysm. Note how the ballooning of the artery is clearly visible in the marked area.**



**This patient has a subdural hematoma. Note the displacement of blood vessels in the marked area.**



**This patient has an infarction. Note the occlusion (blockage) of the blood vessel in the marked area.**



**This patient has a brain tumor. Note how the blood vessels have been pushed out of the marked area by the abnormal growth.**



Angiography cannot be used on patients with allergies to contrast dyes (iodine, crabs, shellfish).

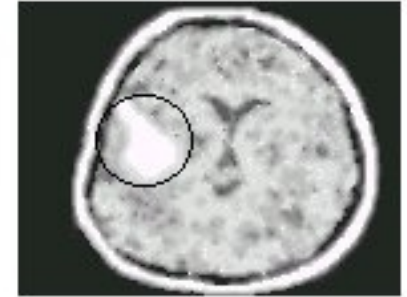
# Diagnostic Techniques:

## Computed Axial Tomography (CAT) Scan

**This is a normal CAT scan. Note the absence of distinguishing abnormalities.**



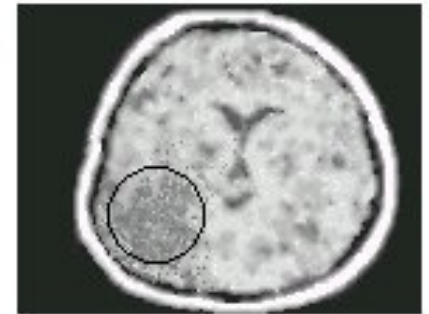
**This patient has an aneurysm. Note the white-colored blot in the marked area.**



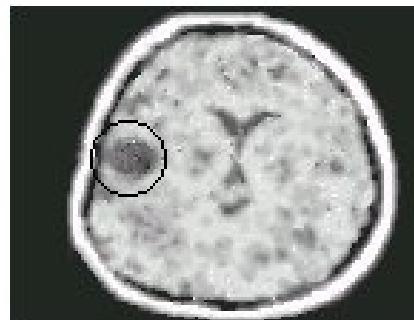
**This patient has a subdural hematoma. Note the light-colored region where blood has pooled and coagulated in the marked area.**



**This patient has an infarction. Note the darker coloring of dead brain cells in the marked area.**



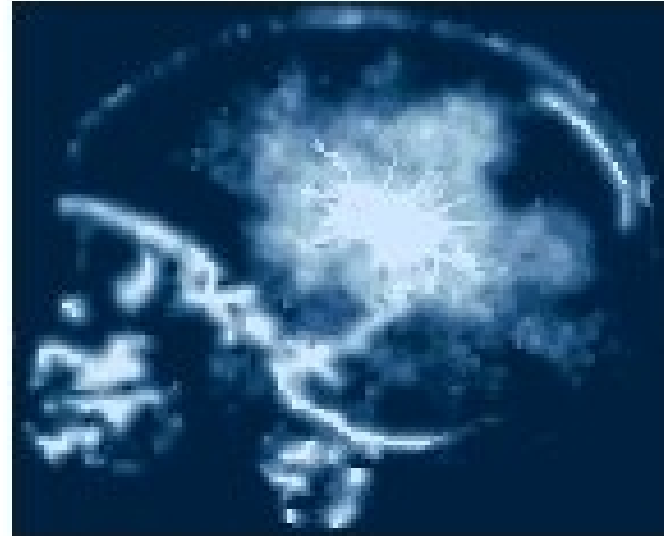
**This patient has a tumor. Note the dark-colored growth in the marked area.**



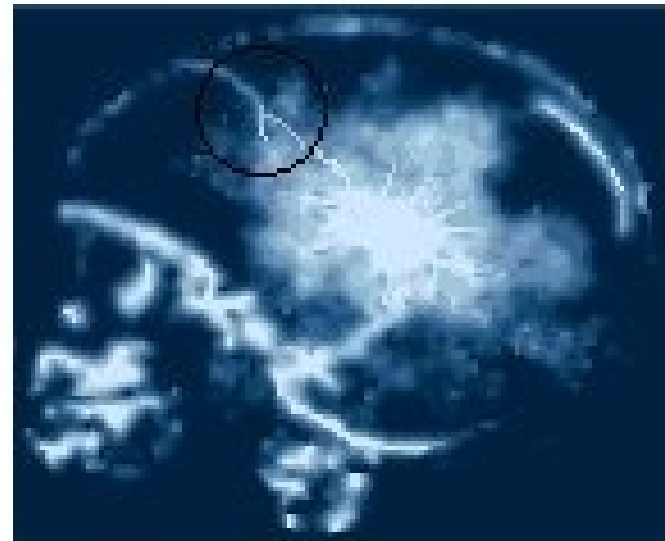
CAT Scans cannot be used on patients with allergies to contrast dyes (iodine, crabs, shellfish).

# Diagnostic Techniques: X-Ray

**This is a normal skull x-ray. Note the absence of fracture lines.**



**This patient has a skull fracture. Note the fracture line in the marked area.**



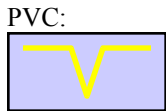
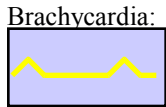
# Operating Techniques: The Operating Room Layout

Patient (Left)

Patient (Right)

Respirator: Low for  $CO_2 < 32$  High for  $CO_2 \Rightarrow 32$  Microscope On/Off Toggle Switch Ultrasound On/Off Toggle Switch

EKG: Shows Heart Rhythm  
Normal is pictured.



LOW RESP. HIGH RESP. Microscope On/Off Ultrasound On/Off EXIT

PCO2 32  
0:00:15 TIME  
110/70 B.P.

EKG

Leave the Operating Room

CO<sub>2</sub> Level

Elapsed Time

Blood Pressure Monitor

Upper tray (click to open)

Lower tray (Click to open)

Bone Saw

Drill (burr hole boring bit installed)

Fine Drill Head

Grinding Burr

Irrigator

Bone Wax - Drag over bone bleeders

Rainey Clips - Click to pick up. Click again to place.

Scalpel

Dissector

Cauterizer

Metal Ribbon

Fishhooks to hold up scalp flap

Urine Collection

IV Drip

Spinal Tap

The O.R. on first entry.

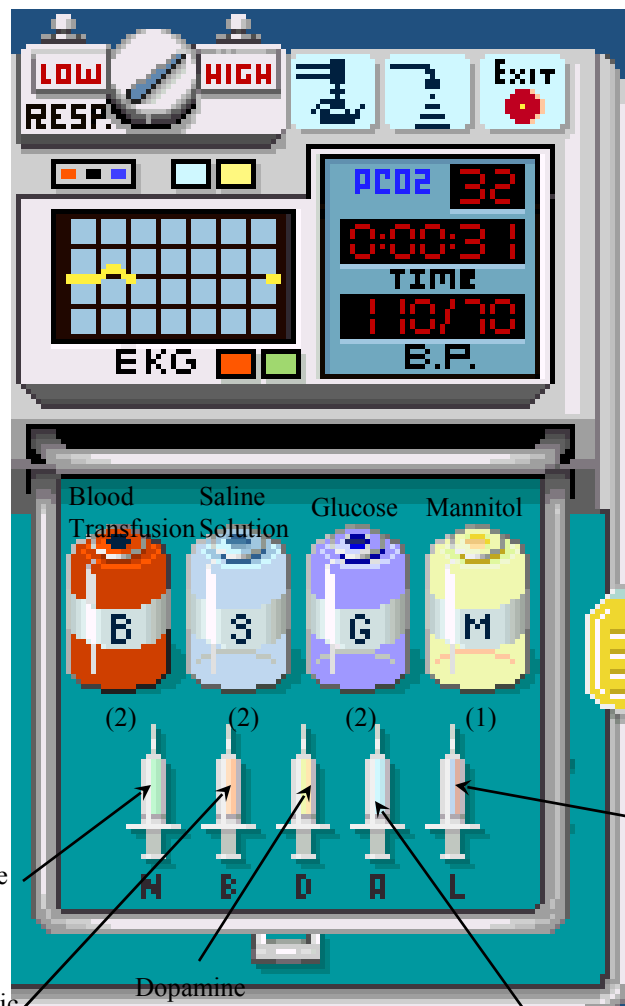
Information Panel

Get to know the location of all of your operating room instruments and their locations and usage.

# Operating Techniques: The Upper and Lower Trays



Upper Tray



Lower Tray

Get to know the location of all of your operating room instruments and their locations and usage.

# Operating Techniques: Beginning the Operation

Before entering the Operating Room, make sure you know:

- 1) what KIND OF OPERATION you're doing
- 2) which SIDE you are operating on

Ready to begin? Here goes:

- 1) Click on the soap to scrub up.
- 2) Click on the latex gloves to put them on.
- 3) Turn the patient's head by using your (gloved) hand to expose the side you need to work on. (This could well be the most important step in the entire procedure!)
- 4) Click on the Betadine and carefully swab the entire head area. Make sure you cover it all (see Diagram 1). In this Diagram, the RIGHT side of the patient's head is being prepped for the operation. the brown area shows where Betadine has been applied.
- 5) Inject the patient with Antibiotic ("B" needle in Lower Drawer). Click to pick up the syringe, then click anywhere on the patient.
- 6) Click on the Drape to pick it up then click on the patient to prepare the area for surgery. After draping, the patient's head should be exposed as in Diagram 2. Note the cutting line where the scalp will be incised.
- 7) The next step will be to provide a blood transfusion and then incise the scalp. Close the Upper Tray by clicking on it, and open the Lower Tray. You only have two bottles of blood so you'll need to work fast. When doing work that causes bleeding, a Blood Transfusion helps keep the Blood Pressure (BP) up. If BP falls too low (below about 60/40 unless artificially induced using nitroprusside) the patient will die. Use the Dopamine injection as a last resort if BP falls too low. To save blood for when it's really needed, insert a Saline or Glucose drip in the IV when the patient is stable and there is no work going on that will cause the patient to lose blood.
- 8) Throughout the operation, keep an eye on PCO<sub>2</sub> level. if it drops below 32, shift the respirator to LOW. If it rises to 32 or above, shift it to HIGH. If PCO<sub>2</sub> level gets too low or too high, the patient will expire.
- 9) Throughout the operation, keep an eye on Urine Level. If it begins dropping, install Mannitol in the IV drip until level recovers. If urine flow stops, the patient dies.
- 10) Always keep an IV drip of some sort going. If the IV runs out of liquid, the patient will die. You could even use Mannitol if you've run out of all other liquids. Note: you have a limited supply of liquids, so work fast!



Diagram 1.

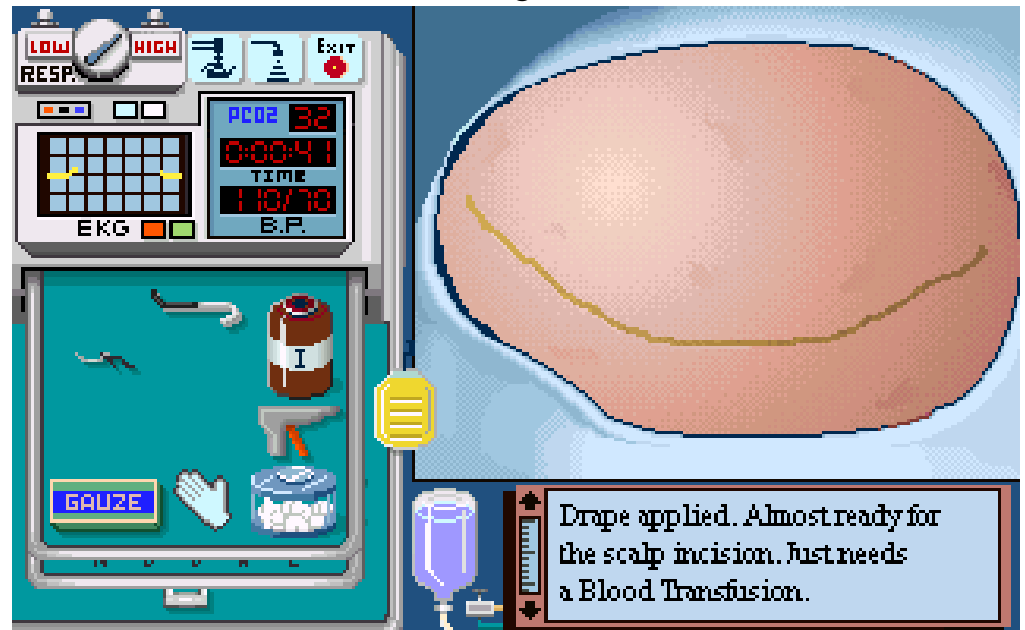


Diagram 2.



# Operating Techniques: Opening the Scalp

This step assumes the basic prep has been completed through draping the patient.

- 1) Insert a Blood Transfusion into the IV drip. Work quickly and efficiently now!
- 2) Using the scalpel, cut about 1/3 of the way along the cut line on the scalp. this should expose about 8 “bleeders” (the scalp has lots of capillaries and bleeds heavily when cut)
- 3) Put down the scalpel and grab Rainey Clips, attaching them rapidly one after another to the bleeders. Clip the largest bleeders first. Work fast! Diagram 3 shows the first 1/3 scalp cut, with bleeders clipped.
- 4) Use the scalpel to make the next 1/3 cut, exposing 6-8 more “bleeders”.
- 5) Put down the scalpel and rapidly clip the bleeders one after another, clamping the biggest bleeders first. Diagram 4 shows the completion of the second incision.
- 6) Make the last 1/3 cut, and clip the last 4-6 “bleeders”. You should have 20 Rainey Clips installed when you finish. See Diagram 5.
- 7) Next step is to open the scalp flap and begin drilling as necessary.

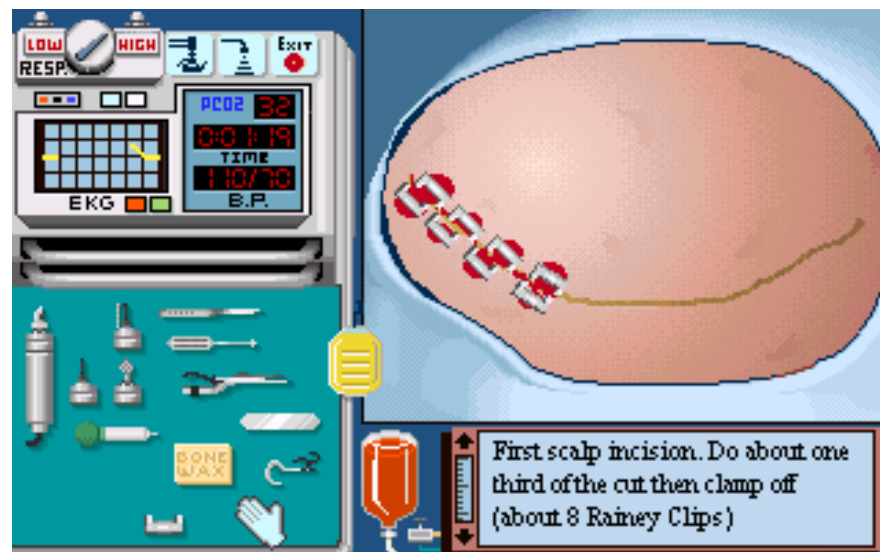


Diagram 3.



Diagram 4.



Diagram 5.

# Operating Techniques: Opening the Scalp (Cont'd)

After the scalp has been cut and clipped, Pull the scalp flap up with your gloved hand to “loosen” it from the rest of the scalp. Let it drop. then take the fishhooks from the tray and click on the scalp flap to hook it up into position. Diagram 6 shows the completion of this step.

If you are doing a Subdural Hematoma operation, you’ll see the skull fracture (assuming you opened the correct side of the head and your diagnosis was correct). Diagram 7 shows what this looks like.

If you are doing a Tumor Removal or Aneurysm Treatment, the skull will look like Diagram 6. Refer to the next step, “Opening the Skull” if you are doing one of these operations.

## Tumor or Aneurysm Operation

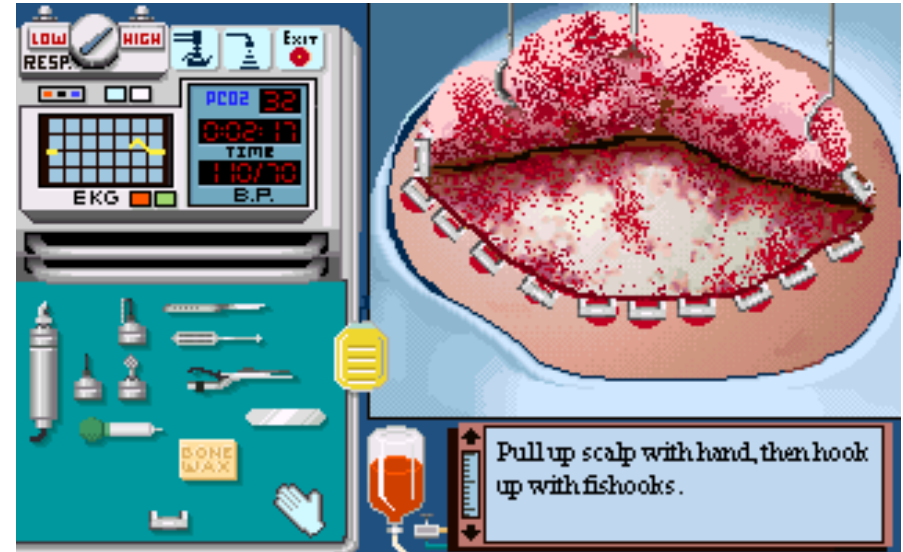


Diagram 6.

## Subdural Hematoma Operation

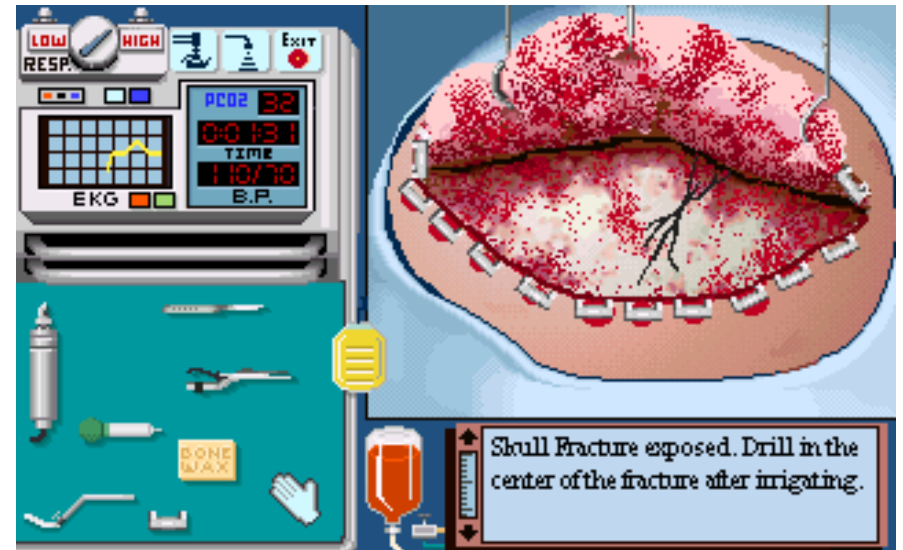


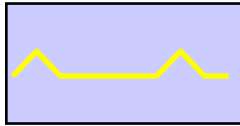
Diagram 7.

# Operating Techniques: Emergency!

If the EKG shows an abnormal heart rhythm (Brachycardia or PVC) STOP WHATEVER YOU ARE DOING IMMEDIATELY AND ATTEND TO IT!!! You have much less than a minute to fix the problem or the patient will die.

The fix is easy: just inject the CORRECT syringe into the patient. Injecting the WRONG syringe will kill the patient (and ruin your reputation).

Diagram 8 shows the patient in a BRACHYCARDIA rhythm. It is shown by an EKG trace that looks like this:

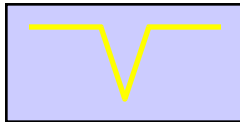


Put down whatever you have in your hand, open the Lower Tray, select the Atropine syringe (Syringe A) and inject by clicking on the patient's scalp. Either the abnormal rhythm will cease, or the patient will die (you picked the wrong one). Remember: BRACHYCARDIA => 2 humps => "A"



Diagram 8.

Diagram 9 shows the patient in a Premature Ventricular Contraction (PVC) rhythm. It is shown by an EKG trace that looks like this:



Put down whatever you have in your hand, open the Lower Tray, select the Lidocaine syringe (Syringe L) and inject by clicking on the patient's scalp. Either the abnormal rhythm will cease, or the patient will die (you picked the wrong one). Remember: PVC => Inverted Hump => "L"

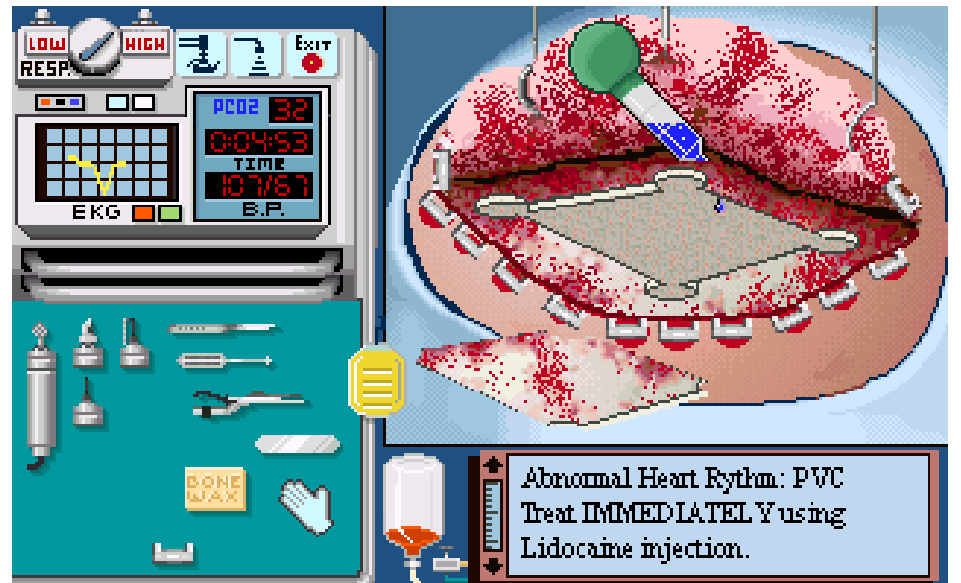


Diagram 9.

# Operating Techniques: Subdural Hematoma

After opening the scalp, you should see the skull fracture (if you don't, you either picked the wrong side, or misdiagnosed).

- 1) Irrigate the center of the skull fracture.
- 2) Drill a burr hole in the center of the fracture. Position the drill under the irrigation drip. Press and hold the mouse button - don't move the drill! As soon as the pitch of the drill rises and the hole appears, let go of the mouse button, or you'll drill too far and kill the patient.
- 3) Using the scalpel, make a small horizontal cut in the Dura through the burr hole. See Diagram 10.
- 4) Using the suction tool, insert the right tip of the tool into the burr hole. Click and hold. You should see the tube turn red as the pooled blood is sucked out. See Diagram 11. Let go immediately as soon as the tube turns white. If you hold on too long, the patient will die.
- 5) Next, pick up the drain tube from the Upper Tray. Position the left (curled) end of the drain tube into the burr hole. See Diagram 12.



Diagram 10.

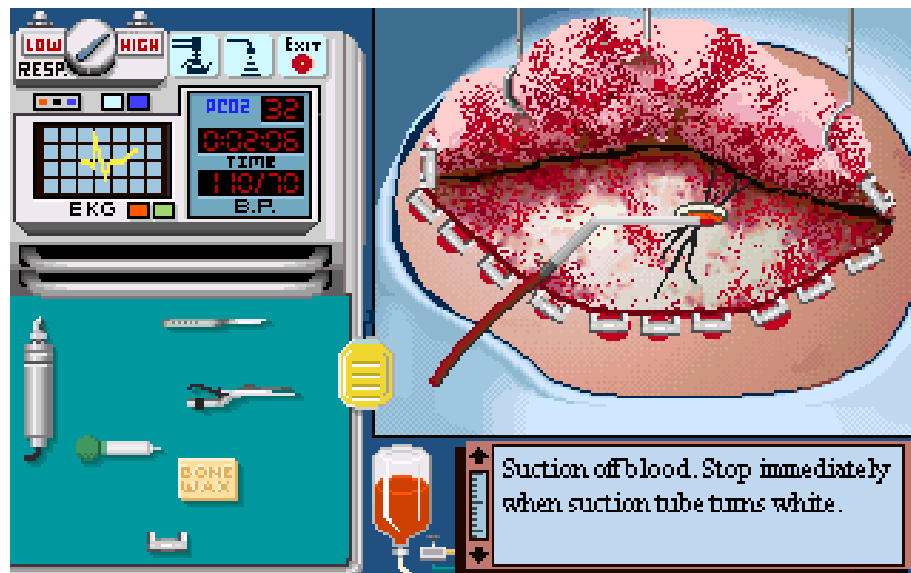


Diagram 11.



Diagram 12.

# Operating Techniques: Subdural Hematoma (Cont'd)

- 6) Once the drain tube is properly positioned in the burr hole, click to put it in place.
- 7) Take the suture from the Upper Tray, and click on the tube near the scalp to insert one suture to hold the drain tube in place. See Diagram 13.
- 8) That'll do it for the Subdural Hematoma operation. Close using the normal procedure (starting at Step 6 of the closing procedure).
- 9) After closing, the drain tube will protrude from under the scalp. This is normal. See Diagram 14.



Diagram 13.



Diagram 14.

# Operating Techniques: Opening the Skull

This technique assumes the scalp has been normally opened. It's needed for Tumor and Aneurysm surgery.

1. Irrigate Position 1 on the skull. Drill hole; wax bleeders.
2. Irrigate, drill and wax positions 2, 3, and 4.
3. Use Dissector to dissect each hole (click once in each hole).
4. Use bone saw attachment to cut from hole to hole to form the "diamond" shape shown. (See Figure 1)
5. Ensure patient stabilized and Blood Transfusion in place. Click on skull flap and drag it to the drape. Immediately wax all bone edges then cauterize any bleeders. Wipe away blood and cauterize/wax any remaining bleeders.
6. Irrigate immediately and every minute or so until complete.
7. Using the grinder attachment, grind all bone edges and grind off the Sphenoid Ridge. **DO THIS ALL IN ONE OPERATION!** (See Figure 2) When grinding is done, wax all bone edges and wipe.
8. You can inject nitroprusside now to reduce BP if you like. After injecting:
  - a. Insert metal ribbon under each bone edge. Use fine drill to drill a hole midway between each position (at points A, B, C, and D - See Figure 3).
  - b. Use fine drill to drill matching holes in bone flap then drill additional hole in center of bone flap. Put bone flap on tray.
  - c. Add suture to points A, B, C, D, and X (See Figure 3).
  - d. If not already done, inject nitroprusside.
  - e. With hand, check brain tension. If tight, open then close spinal tap and check again. When relaxed, wait until BP reaches 50/30.



Figure 1.



Figure 2.



Figure 3.

# Operating Techniques: Opening the Dura Mater

Opening the Dura Mater assumes the skull has been properly prepped.

1. Ensure BP is 50/30 and patient is stable. Insert Blood Transfusion. Irrigate.
2. Begin the Dura Mater incision at the position shown in Figure 4, cutting slowly in the counterclockwise direction using the scalpel. Make the first cut small, about 1 inch or so because there will be lots of bleeding. After the first cut is made, cauterize bleeders immediately. Wipe, then cauterize again if necessary.
3. Continue cutting carefully along the bone edge, cauterizing if necessary. Wipe as needed. Don't cut into the burr holes. The second and later cuts can be longer if bleeding was properly stopped in step 2. Stop cutting as you get to the last hole. **DO NOT CUT ALL THE WAY THROUGH!!** Your final situation should look like Figure 5.
4. Apply wetted gauze onto the skin flap. This will keep the retracted Dura moist through the rest of the operation.
5. Hold your breath, and retract the Dura with your hand. If you properly ground all the bone edges during skull preparation, and you cut the Dura properly, you will be greeted with what you see in Figure 6. If not, the Dura will have been sliced and the patient will die.
6. Make sure the patient is stabilized. Replace Blood Transfusion with Saline or Glucose, and proceed to Tumor Removal procedure or Aneurysm Procedure.



Figure 4.



Figure 5.



Figure 6.

# Operating Techniques: Treating Tumors

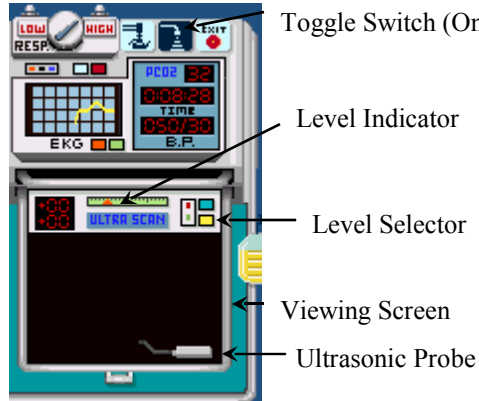


Diagram 15 shows the Ultrasonic system used for finding those pesky tumors. Use the Toggle Switch to turn it On or Off. To use it, pick up the probe, and run it over the brain area. You're looking for a white peanut shaped blot on the Ultrasonic screen. If you don't see it, put the probe down, and push the Level Selector to change to Level 2. There are 5 Levels of tissue in the brain. The tumor will be located in one of the top 3 Layers. Pick up the probe and look again. If there's still no tumor, put down the probe, select level 3, and search again. When you find the tumor, note the X value, Y value, and Level the tumor is on. Diagram 16 shows a tumor located at  $X = -25$ ,  $Y = +12$  on Level 2. (The center crosshairs are at  $-22$ ,  $+12$  and the tumor is just to the left of the crosshairs). After noting the position and level, turn the Ultrasonic system Off by hitting the toggle switch. Next, we get rid of that tumor.

Diagram 15.



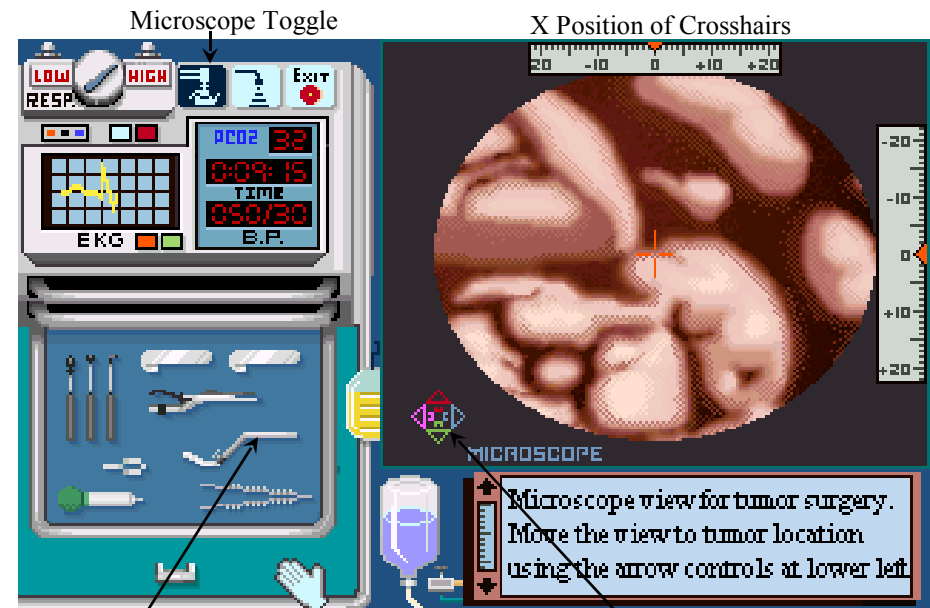
Diagram 16.



# Operating Techniques: Treating Tumors (Cont'd)

Once you've located the tumor using ultrasound, and know the X/Y location and level, you can get rid of it. Here's how:

- 1) Remove the irrigation and turn on the microscope. You'll see something that looks like Diagram 12.
- 2) Using your hand, adjust the microscope to get the crosshairs near the tumor's X and Y locations by clicking on the arrows at the lower left of the microscope screen. They're very sensitive. You just have to get the crosshairs close, not exactly right on top of the tumor.
- 3) When you're close, pick up the suction tool (it looks like a soda straw) and position the right tip of it near where you think the tumor is. Every time you click, the suction will remove 1 layer of brain tissue, and the tissue will change color to let you know. So if the tumor was on level 2, you'd have to click twice to reach level 2. If you see black, that's a piece of the tumor (See Diagram 13). Click on the black to suck it out. Don't suck any further!
- 4) Move the suction to a space next to the first. repeat step 3. If you don't see any black at the level you expect, then stop and move to a new spot. Continue in an orderly pattern to remove the tumor. Stop somewhere in the middle to turn off the microscope and irrigate the brain for a bit, Then resume until you think you've gotten all of it. You should make sure by removing enough good tissue around the border to ensure it's all gone (Diagram 15 shows this pattern). When finished, put down the suction, turn off the microscope, and irrigate. Then close up.



Suction Tool

Diagram 17 Controls for Microscope



Diagram 18



Diagram 19

# Operating Techniques: Treating Aneurysms

This procedure assumes that the skull and Dura Mater have been properly opened. This description is for a RIGHT SIDED Aneurysm. Left Sided Aneurysms appear slightly different from the pictures, but the technique is the same, except as noted.

1. Ensure patient stable. Remove irrigation and click on microscope. If you ground off the Sphenoid Ridge properly, you'll see the Sylvan Fissure (See Figure 7). If not:
  - a. Turn off the microscope, irrigate, close the Dura Mater, and regrind the Sphenoid Ridge area
  - b. Open the Dura Mater, remove irrigation, and turn the microscope back on.
2. Select Forceps; click to the left of the Sylvan Fissure. This elevates the outer artery.
3. Select the Microscissors or Rhoton Knife. CAREFULLY cut the Arachnoid Membrane directly at the Sylvan Fissure (see Figure 7). If you cut outside the line, the patient dies.
4. Remove the Microscissors/Knife, and the Forceps. Select a retractor. For a RIGHT SIDED Aneurysm, set the LEFT retractor first. For a LEFT SIDED Aneurysm, set the RIGHT retractor first.
5. Select the other retractor. Click and CAREFULLY drag the lobes apart about 1/2 inch to expose the connecting vessels (Figure 8). Drag the RIGHT retractor for a right side operation and vice versa for a left side operation throughout the procedure.
6. Use the Microscissors to clip the center connecting vessel. Cauterize. Drag the lobes apart more to expose the bleeding if required. Irrigate at least every one minute.
7. CAREFULLY retract lobes to expose the 2nd Arachnoid Membrane. Too far open will kill the patient! Thumbrule: no more than 1/2 the optic nerve should be exposed. See Figure 9.



Figure 7.

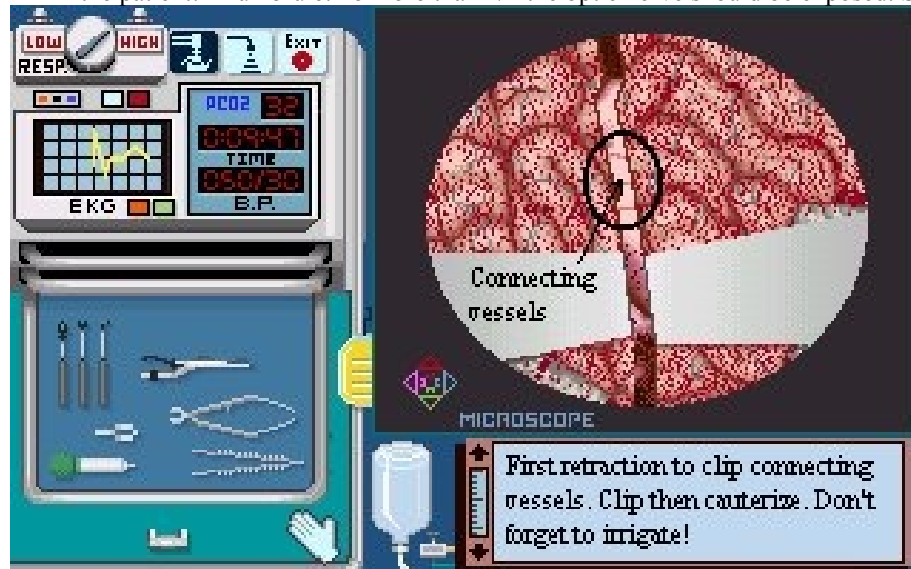


Figure 8.



Figure 9.

# Operating Techniques: Treating Aneurysms (Cont'd)

- Using the Microscissors or Rhoton Knife, CAREFULLY cut the 2nd Arachnoid Membrane. This doesn't need to be a real long cut. Do NOT cut the Carotid Artery or the Optic Nerve. If you get too close to either: GAME OVER. See Figure 10. for proper location of the cut.
- Locate the Aneurysm. Remove Irrigation and reposition the microscope down to work on it. Don't forget to Irrigate every minute or so.
- Select the Rhoton Dissector (with the "Teardrop" end). Click on the center of the aneurysm and drag DOWN once and you should see something like Figure 11. DON'T start too high or you'll damage the Optic Nerve or Carotid Artery.
- Click and drag DOWN on the aneurysm again with the Rhoton Dissector and you'll see the aneurysm ball even more clearly (see Figure 12). The aneurysm is the rightmost "butt cheek" of the little "hiney" looking ball. It's crossed by a set of veins.
- Did I mention: "Irrigate often" to prevent the brain from drying out? Make sure you do or the patient will die. Hang in there - almost through.



Figure 10.



Figure 11.



Figure 12.

# Operating Techniques: Treating Aneurysms (Cont'd)

13. Select the Rhoton Hook (the one with the “L” shaped end, and carefully pull the veins DOWN and out of the way of the aneurysm. See Figure 13.
14. Select the Rhoton Dissector (the one with the “Teardrop” end) and CLICK on the aneurysm ball ONCE as shown. The appearance of the ball will change as the dissector begins to loosen it up so it can be “pinched” See Figure 14.
- 15 Using the Rhoton Hook, CAREFULLY scrape (click and drag) the area just under the aneurysm ball a few times until the ball “pops” up, exposing the “neck of the aneurysm. When you’re successful, you’ll see something that looks like Figure 15.
16. All the while, make sure you occasionally check respiration, and IV level (use Saline or Glucose). Don’t forget to irrigate, too.



Figure 13.



Figure 14.

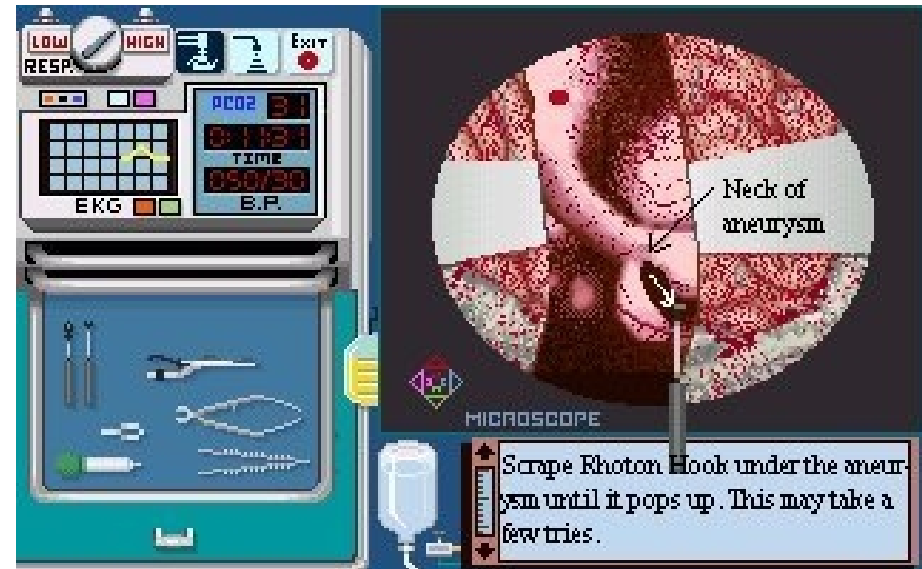


Figure 15.

# Operating Techniques: Treating Aneurysms (Cont'd)

17. Lastly, select the aneurysm clip, and click on the neck of the aneurysm, as shown in Figure 16. This'll clip the aneurysm off, and prevent it from bursting.
18. Select the RIGHT (LEFT) retractor and replace it on the tray. The brain lobes will relax back into position.
19. Select the other retractor, and place it on the tray.
20. Turn off the microscope, and irrigate.
21. Check to make sure the patient is stable, then close normally.



Figure 16.

# Operating Techniques: Closing Up

After the operation is complete, it's time to close up. If you're finishing from a tumor removal or aneurysm repair, start here. If it's a Subdural Hematoma, start at step 6 below.

- 1) Use hand to close the Dura Mater flap. Remove gauze and put it on the tray.
- 2) Use the suture to carefully apply 10 or more sutures around the cut in the Dura Mater (see Figure 17).
- 3) Take the bone flap from the tray and replace it in the skull.
- 4) Click on each suture hole with your hand to tie off all 5 sutures between the skull flap and the skull (positions A, B, C, D, and X). See Figure 18.
- 5) Remove irrigation.
- 6) Remove the fishhooks and allow the scalp to fall back into place.
- 7) Remove all 20 Rainey Clips from the scalp and put them on the tray.
- 8) Use the Staple Gun to insert 10 staples across the scalp wound. If the operation was for a Subdural Hematoma, the drain tube will be protruding from under the scalp flap. This is expected. See Figure 19.
- 9) Operation complete! An average time for an aneurysm or tumor removal is about 12 minutes from start to finish. Average time for a Subdural Hematoma repair is significantly shorter (3-4 minutes).



Figure 17.



Figure 18.



Figure 19.