Ultrasound-Guided Regional Anesthesia in the Obese Patient

Dr. Robert M Raw, MD
MBChB, MFGP, MPraxMed, DA, FCA
Professor of Anesthesia retired.
Editor of Regional-Anesthesia.Com

Dr. Raw has no conflicts in interests relating to this lectures contents.

Index

---

1. INRODUCTION

Obesity is a disease that causes many surgical and anesthetic problems. Regional anesthesia offers many benefits in the obese patient undergoing surgery. Obesity in turn creates many challenges in performing regional anesthesia. The ultrasound is an added nerve localizing tool for the regional anesthesiologist. This lecture shall review ultrasonography for regional anesthesia in the obese patient.

It is however first necessary to take an overview specifically of (1) the surgico-anesthetic problems associated with obesity and (2) the advantages and disadvantages of regional anesthesia in obese patients undergoing surgery, and then finally examine the role of ultrasonography in performing regional anesthesia.

Obesity increases the technical challenges of both surgery and regional anesthesia.

Obesity is not ugly. Every person however they physically appear, is beautiful to someone. This lecture respects all patients, and is concerned with health risks and the technical challenges in providing regional anesthesia.

2. OBESITY AND ITS ANESTHETIC IMPLICATIONS[1,2]

Obesity is present in persons 20% or more over their ideal body weight. Obese is thus having a Body Mass Index (BMI) at or higher than 27 in men and 28 in woman. BMI = weight (kg)/height^2(M). Sixty four percent of the USA population is overweight, a rate that doubled in 10 years up to 2005. A centralized mass distribution has worse health implications than a peripheral mass distribution. Obese and particularly morbidly obese persons (BMI > 35 or >40 by some newer definitions) are at risk of the following health disturbances. Only those with potential to derive some benefit from regional anesthesia are listed.

1. Obstructive sleep apnea (OSA). These obese OSA patients are doubly prone to post-operative hypoxemia and hypercarbia, sudden death and are extra sensitive for the respiratory effects of opiates.
2. Altered lung volumes. There is a restrictive lung disease ventilation pattern with;
   i. Decreased functional residual capacity (FRC)
   ii. Decreased end expiratory reserve volume (ERV)
   iii. Decreased Total Lung Capacity (TLC).
   iv. There is high closing volume with a tendency to atelectasis.

   General Anesthesia and sedation increase all those changes. The use of PEEP with ventilation, although recruiting some collapsed alveoli does that at the cost of decreased venous return and cardiac output.
3. There is increased work of breathing which in turn leads to;
   i. Hypoventilation with any sedation.
   ii. Hypoxemia from diaphragmatic tamponade from a large abdomen.
4. Ischaemic heart disease. Sympathetic stimulation with tachycardia and hypertension can induce myocardial ischemia.
5. Congestive heart failure.
6. Delayed gastric emptying with a need to for rapid sequence intubation.
7. Increased difficulty with intubation.
8. Increased Thrombo-embolic disease.
9. Technically more difficult surgery.

Optimum postoperative analgesia reduces sympathetic stimulation and avoidance of opiates protects from respiratory depression and sedation. Regional anesthesia alone can achieve all of this.

3. BENEFITS OF REGIONAL ANESTHESIA IN OBESITY

Regional anesthesia compared to using general anesthesia and or large doses of opiates offers;

1. Minimal airway intervention (with awake surgery).
2. Less cardiac depression (less volatile and intravenous anesthesia).
3. Less ventilatory depression from general anesthetic drugs.
4. Less respiratory depression from use of opiates.
5. Less stress and sympathetic responses from pain.
6. Less nausea from avoidance of opiates or reductions in opiate doses.
7. Reduced stay in high-care/ high-cost units.
8. Reduced general morbidity and mortality.

4. EFFECTS OF OBESITY ON REGIONAL ANESTHESIA

The Nielsen study is the largest one[3]. They prospectively reviewed 9 038 blocks done on 6920 patients in an ambulatory setting on patients over 13 years old. The commonest block performed were Sciatic, paravertebral, interscalene, lumbar plexus, spinal, femoral, axillary and supraclavicular blocks. Most surgeries were for orthopedic and general surgery. See table 1 and 2.

Block	Frequency (%)		
	Single shot	Continuous	total
Sciatic	17.1	3.2	20.3
Paravertebral	18.0	-	18.0
Interscalene	12.7	4.4	17.1
Psoas compartment	10.1	2.5	12.6
Spinal	9.8	-	9.8
Femoral	6.1	0.1	6.2
Axillary	5.5	0.2	5.7
Supraclavicular	4.6	0.1	4.7
Ankle	2.5	-	2.5
Saphenous	0.9	-	0.9
Epidural	-	0.6	0.6
Wrist	0.2	-	0.2
Superf. Cervic. Plex.	0.2	-	0.2
Infraclavicular	0.1	0.01	0.11

Table 1. Frequencies of nerve blocks. Nielsen[3]

They found that in obese patients;

1. **A greater likelihood of block failure -** increased significantly from 9.5 % in the normal patients (as defined per protocol) to 12.9 % in the morbidly obese patients.
2. **Acute block complications increased** significantly from 0.2 % to 0.7 % in the morbidly obese patients.
3. **Obese patients were however not less satisfied** despite the failures and complications.
4. **Obese patients experienced better pain scores in PACU**.

The failed blocks were most likely in psoas compartment blocks and in interscalene catheters. The reasons for the better pain experience of the obese patient in PACU despite having more failed blocks, can only be speculated.

Possible reasons for this observation are that obese persons have;

1. A different psychology weighted to having thankful uncomplaining personalities, compared to normal persons.
2. A higher incidence of peripheral sensory neuropathy either due to the higher incidence of diabetes mellitus or other obesity related illnesses.
3. A statistical type 1 error.
4. Some other yet unrecognized observation.

Type of surgery	Frequency
Orthopedics	60.8
General	30.0
Urology	4.6
Plastics	3.1
Gynecology	1.4

Table 2. Frequency of surgery types. Nielsen[3]

Two other studies found weight did not increase failure rate or complication rate in mid-humerus blocks, and interscalene blocks, whilst a third study found obesity did increase failure weight with suprascapular blocks[4, 5, 6]. These studies were however very small. Another interscalene study found that in obese patients, the procedure took in minute longer to identify the target nerves in obese patients and that there was also a tendency for a lower success rate[7]. Hanouz studied 605 patients retrospectively who had had axillary plexus blocks[8]. Success rates were 98% in non-obese patients, but that reduced to 91% in obese patients with 5% more elbow nerve blocks being done as rescue blocks

A survey of 250 parturients receiving epidural anesthesia in obstetrics showed that compared to thin patients, obese patients tended to get higher epidural blocks for the same doses particularly if they lay down and the difference was up to 4 segments higher if obese and lying down[9]. Complications were much more common at 27% versus 9% and predominantly were vascular punctures. Also, only 87% of obese patients expressed satisfaction with anesthesia care versus 94% of the non-obese patients.

Obese persons have been shown to have a higher incidence of symptomatic carpal tunnel syndrome and obese persons in general also have slowed median nerve conduction across the wrist with nerve swelling. Asymptomatic (for carpal tunnel syndrome) obese person however still have normal carpal tunnel pressures despite the nerve swelling[10].

5. THE EFFECTS OF ULTRASOUND ON NERVE FUNCTION.

It is widely believed that ultrasonography is without effect on peripheral nerves. It is known that ultrasound has potential to warm the tissues exposed to sufficiently high sound energy. This is an intentional physical modality of therapy for some tissue injuries.

A theoretical concern in obese patients, is that nerves can be exposed to longer ultrasound scanning that usual due to the increased technical challenges of the nerve block.

Ultrasonography is increasingly being used both for locating nerves for nerve blocks and in diagnosing nerve disease. Studies are now looking at some aspects of potential nerve injury.

Moore (2000) was able to identify changes in conduction latencies attributable to tissue heating effects of ultrasound[11]. There were no apparent clinical consequences. An earlier study (1983) with a different methodology for no electromyographic differences induced by ultrasound effects on to nerves[12].

To date, in 2018, there is no yet proven reason for concern regarding clinical practice. It does however seem logical to not scan one tissue point containing a major nerve for a period exceeding some period, perhaps ten minutes. Such a circumstance could arise during a demonstration for device marketing or educational purposes.

6. THE EFFECTS OF OBESITY UPON ULTRASOUND IMAGING

Obesity can severely conceal the surface anatomical land marks used to identify the location of peripheral nerves. The excess skin and subcutaneous fat tissue can also restrict anatomical access to the optimal needle insertion point for a planned nerve block. Lastly the distance from the skin to the nerve is usually increased.

Increased skin to nerve distance degrades the ultrasound image of all of the tissues usually viewed during ultrasound imaging. Nerves which can normally be seen may become fully invisible. Some large unitary nerves however gain a hyperechoic form of image and can in fact be more easily identified amongst the other darker tissues. The popliteal fossa sciatic nerve is the best example of this.

High frequency linear transducers in the 8 to 14 MHz range have an optimum imaging range of 1 to 5 cm deep. These transducers produce the best tissue resolution. In obese patients for some particular nerve blocks the nerve block may be impossible using a linear transducer.

Low frequency curved transducers in the 3 to 7 MHz range can produce tissue images down to 15 cm from the skin. They yield best tissue penetration, but with the lowest resolution.

It is fortunate that nerve electro-stimulation can be used as well. That means it is not necessary to see the nerve on the ultrasound image. With good anatomical knowledge and ultrasound imaging experience, a surrogate anatomical marker can be used. A surrogate anatomical structure will have consistent and predicable anatomical relationship to the (invisible) nerve. A surrogate can be an artery. The needle is directed towards the surrogate on the side where the nerve(s) are expected to lie. The motor responses from the needle stimulation will indicate precise needle to nerve contact. It is in fact not even necessary to see the needle tip. In fact, if only the proximal needle is visible it can be sufficient to indicate the *direction* in which the needle is to be pointed. One could regard this then, as an ultrasound-aided blind nerve block technique. One needs great caution and great experience if there are critical tissues in the region at risk of needle injury, like the pleura.

The biggest limitation of the impaired imaging that results from obesity upon ultrasound guided nerve blocks is mental on the side of the person performing the nerve block. They have to have a very clear mental image of what the sectional anatomy is in the region where they are working. They need to ability to mentally impose those anatomical structures into the crude fuzzy image they are working with. Not seeing a structure does not mean one should not be knowing exactly where it is.

7. SPECIAL CONSIDERATIONS FOR SPECIAL PROBLEMS OR SPECIFIC NERVE BLOCKS

A. PHRENIC NERVE BLOCK CONCERN.

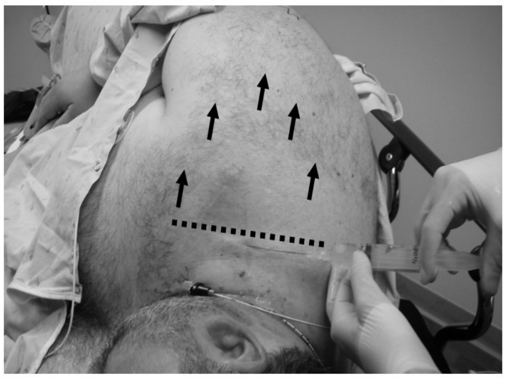
Where shoulder surgery is being performed the golden standard for the perfect nerve block is the interscalene block. The reason is that it includes the intermediate and lateral supraclavicular nerves and it strongly blocks the suprascapular nerve. In addition, it blocks the pectoral nerves and the axillary nerve all in one easy injection. Unfortunately, with full drug doses the phrenic nerve is blocked 100% of the time. In routine cases that is not noticed and it is clinically inconsequential.

A rule of thumb is if before the nerve block, any extremely obese patient has any discernable **respiratory difficulty** at rest when just sitting, or is unable to comfortably hold a flat supine position without difficulty breathing, be concerned. The patient will certainly not tolerate a phrenic nerve block.

The best alternative nerve block technique for the shoulder surgery is the following;

- <u>Avoid the interscalene block</u> where no 100% phrenic nerve preserving technique modification exists.
- <u>Avoid the supraclavicular brachial plexus block</u>. It has a 20% incidence of phrenic nerve block, and a 80+% incidence of failing to block the suprascapular nerve.

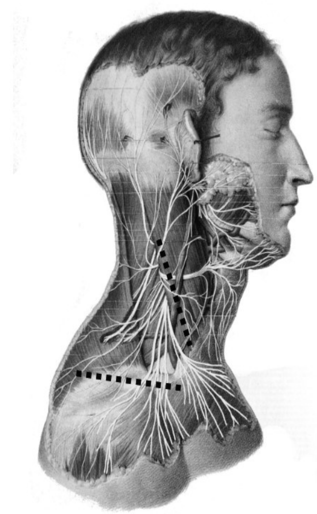
- Do the following three blocks, that include 4 injections;
    - Shoulder-preferred cervical plexus block, which favors blocking the intermediate and lateral **supraclavicular** nerves.
    - Targeted **suprascapular nerve** block, in the lateral supraclavicular region.
    - Infraclavicular block approach to block (i) the posterior cord (and **axillary nerve**) and **both pectoral nerves** immediately anterior to the fascia anterior to the axillary artery and behind pectoralis minor.



- Placed an interscalene catheter
    - Only gave a 15 ml bolus after anesthesia started
- Subcutaneous Supraclavicular (C4) nerve field block

Superficial Cervical Plexus

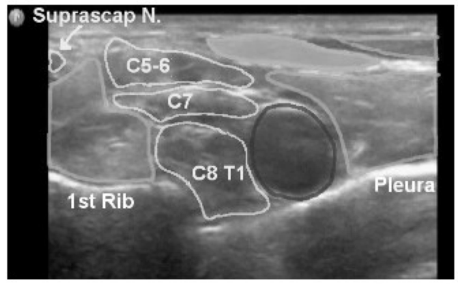
- Inject in a *shoulder preferred* fashion.
- That is ½ cm posterior to the posterior margin of the mid to low section of the sternocleidomastoid muscle

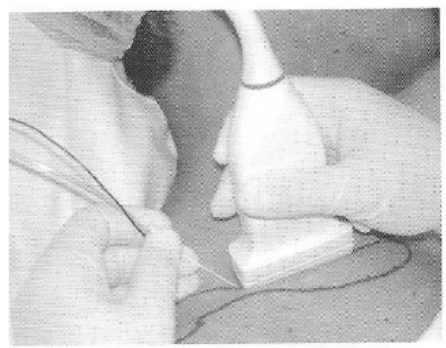


The shoulder preferred superficial cervical plexus block is a simple lengthy subcutaneous infiltration of local anesthetic drug. The optimal needle is Quincke point 22G spinal needle of 90mm length. Ideal drug is 10 ml of 0.5% bupivacaine with adrenaline (epinephrine). Inject, as in the photo, from the trapezius muscle edge forward, to the just over the clavicle. The line of injection should be medial to all likely incisions for the shoulder. This will block the superficial cervical plexus branches of the intermediate and lateral supraclavicular nerves.

Ultrasound Guided Suprascapular Nerve Block

- Start with a supraclavicular brachial plexus block view.
- Find the suprascapular nerve;
  - = It is the most posterior, most cephalad large monofascicular nerve.
- Verify with a nerve stimulator.
- Use an off-plane needle approach.
- Inject 5 m of local anesthetic.



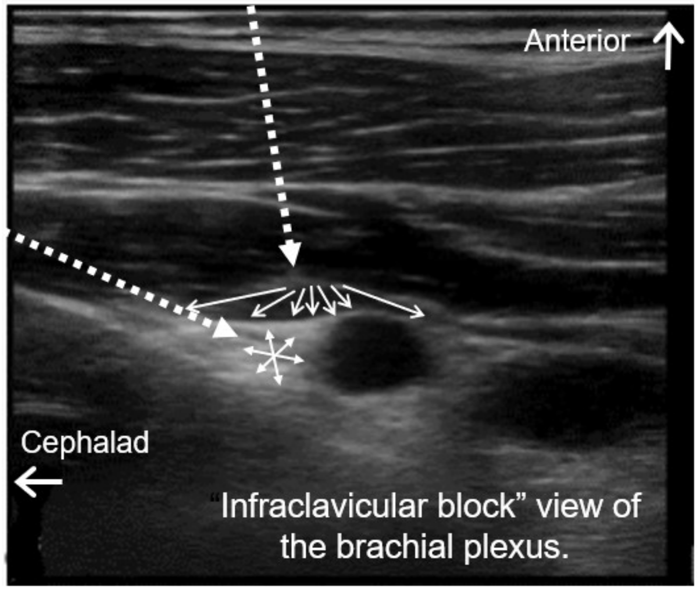


Obtain a view of the supraclavicular brachial plexus with the ultrasound. Next look at the most posterior portion of the brachial plexus. If a solitary relatively large fascicle is seen it is likely the suprascapular nerve. It may be separated from the rest of the plexus. Then rotate the transducer slightly more to an anterior -posterior plane and try to follow that most posterior portion of the plexus with slow gentle glide of about 1 to 2 centimeters. Continually adjust the angle of tilt of the transducer. The supraclavicular nerve will only be identifiable within a tiny range of angles of insonation. If the thin flat lateral head of the Omohyoid muscle can be discerned, typically the suprascapular nerve lies directly underneath it. Soon the suprascapular nerve turns towards the suprascapular notch. This will be observed by the fat that the optimal angle of viewing the nerve requires the transducer be leaned partly towards lateral, while looking to medial. Place a nerve block needle onto the nerve. Use a nerve stimulator set to 1Mhz twitching and 0.60 mAmp current. The needle may be inserted in-plane and from posterior. This author however finds inserting the needle from lateral and off-plane a faster easier technique. Once twitching of the supraspinatus and infraspinatus muscles posterior to the scapular confirm needle nerve contact, then inject 5 ml of local anesthetic drug. This author favors 0.5% bupivacaine.

Axillary Nerve, and the Pectoral Nerves

Pectoral nerves, immediately deep to pectoralis minor muscle.

Axillary nerve, is part of the posterior cord best found at 9 ‘o clock from the subclavian artery



Use an infraclavicular block ultrasound view and insert the needle in-plane from cephalad. As with all multi-injection nerve blocks do the deepest injections first. Aim the needle towards the “9-o’clock” position from the artery and seek the posterior cord using needle electrostimulation to verify needle to nerve contact. Any posterior cord related twitch is satisfactory and the axillary nerve will be blocked. Inject 10 to 15 ml of local anesthetic drug. This author favors 0.75% ropivacaine.

Next redirect the needle more anterior to block the two pectoral nerves. Inject 10 to 15 ml of local anesthetic drug directly anterior to the axillary artery, but *above* the fascia of the axilla. This author favors 0.75% ropivacaine. The drug should spread transvers in the image and under the pectoralis muscle. Needle-to-nerve position does not need stimulation verification.

For the severely obese patient where there is observable reason for concern that any phrenic nerve block will cause respiratory embarrassment, then an interscalene block can be done, but some modifications are still recommended.

First, still inject the superficial cervical plexus in the shoulder-preferred fashion already described. Also place an interscalene catheter. Only inject the interscalene catheter drug main-dose after the patient is intubated and under anesthesia. Also reduce the main dose to 15 ml. That will firstly fail to cover the cervical plexus, and that is the reason it needs to be injected separately. Secondly the interscalene block with such a reduced volume will fail to spare the phrenic nerve in some cases. In the group of patients where the phrenic nerve **is** blocked, it will be a short-lasting block that often resolves within three to four hours from the time of injection, and not persisting beyond a brief period of observation the Post Anesthetic Care Unit (PACU). This technique modification is just to assist with any possibility that phrenic nerve does occur and that the patient becomes distressed despite one's clinical judgements and predictions that it shouldn't.

This author has never met a patient too obese as to make this nerve block impossible.

Shoulder block for an obese patient without concern for breathing problems

- The biggest challenge is to technically identify the interscalene brachial plexus and advance a needle onto it.
- This 220 kg man had previously tolerated an interscalene block without breathing problems.
- We still felt a need to be cautious.

Image used with signed patient permission.

Interscalene block

- Insert transducer into the available skin crevice.
- Use the lateral patient position.
- Insert needle from posterior.

In a patient with a very fat neck, an ultrasound guided interscalene block is best performed in the lateral position. Let the natural single crease in the fat neck be the site to place the ultrasound transducer. Introduce the needle in-plane from posterior. Do not administer the main dose until the patient is asleep under general anesthesia. That avoids any need to deal with any risk of an unexpected pre-anesthetic respiratory difficulty. Inject a main dose of only 15 ml local anesthetic.

The chance of a phrenic block still occurring will be about 15%. In the additional and unlikely event that it is symptomatic, the phrenic nerve should recover motor function before the end of surgery or with an hour after surgery. It is a block component of short duration.

B. ARM SURGERY IN THE OBESE PATIENT.

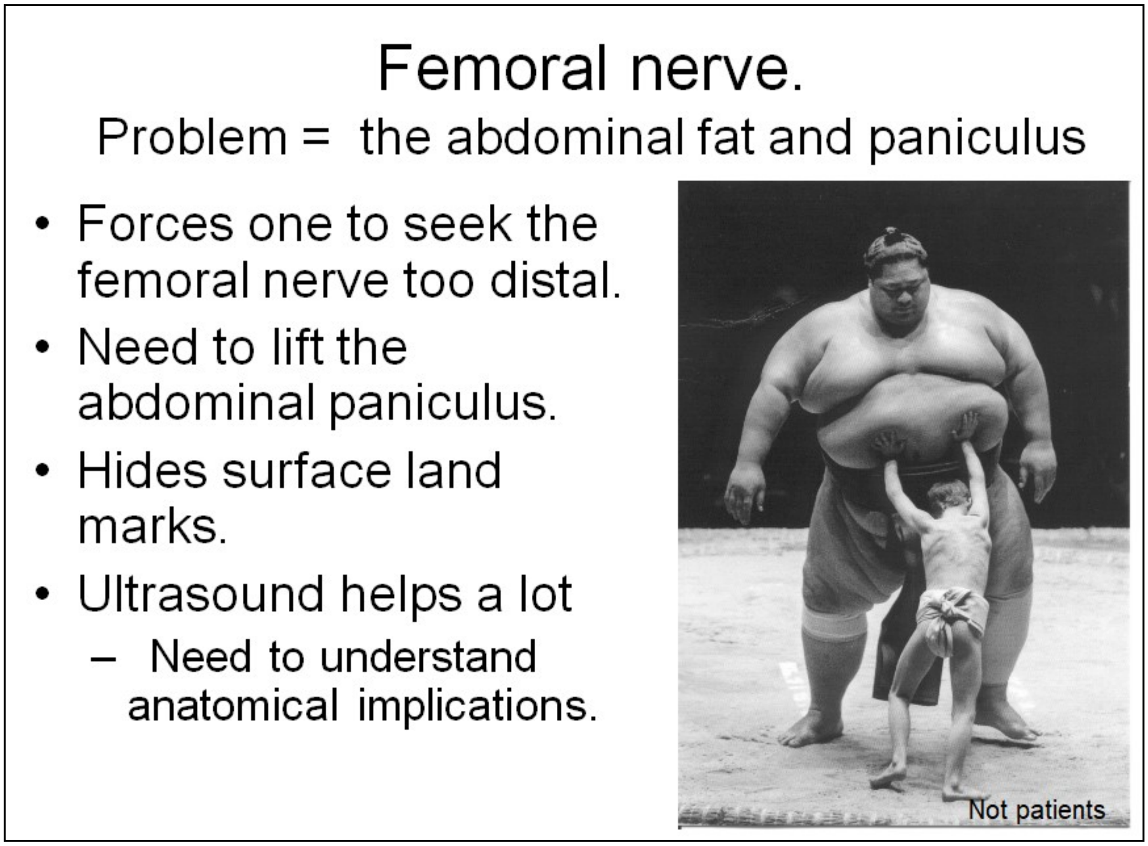
Generally, a standard infraclavicular block with linear transducer is always feasible. Rarely, using a curved transducer is useful. This author has however always succeeded with a 40mm wide linear transducer Although one may let non-obese patients be operated awake or partial anesthetized without airway support, it is often wiser to support ventilation in a morbidly obese person with an endotracheal tube and anesthesia, even if nerve blocked. The patient will still get all the benefits of a nerve block. They will recover very fast from the general anesthetic, as it will have been so light. One does not want a morbidly obese patient to experience many hours of sedated intermittent airway loss and snoring together with burdened breathing and the accumulating effects of hypercarbia and suboptimal oxygenation. Supraclavicular blocks should be avoided due to the double risk of pneumothorax and phrenic nerve block. Only use the axilla block if the infraclavicular route is absolutely unavailable. Axilla block is the least reliable block of the arm.

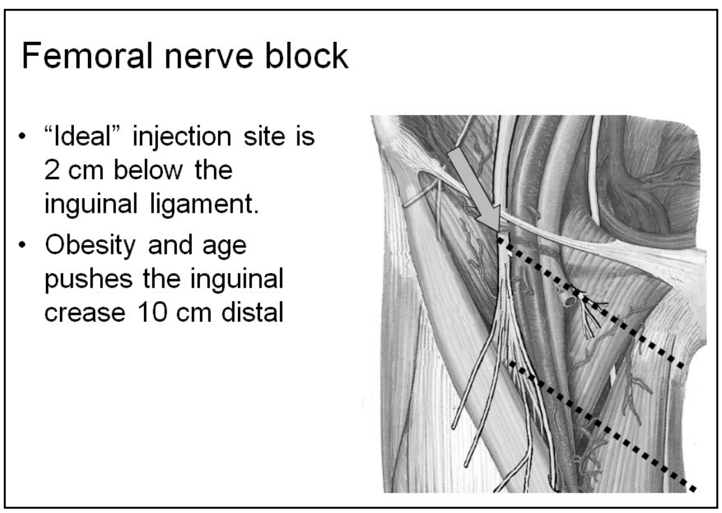
C. ABDOMINAL SURGERY IN THE OBESE.

There is pressing reason to want to use epidural anesthesia for post-surgical analgesia. Without non-opiate analgesia the risk for postoperative hypoventilation and basal atelectasis through the night is very high when using high dose opiates primarily for analgesia. Pre-scanning with ultrasound can help determine the thoracic spine midline. No patient is ever too obese to receive a thoracic epidural block. Skilled operators can perform real time ultrasound guided epidural block, but need a third sterile hand to perform the loss of resistance injection using an extension and syringe attached to the needle.

The tap block although of limited value for intraperitoneal surgery is useful for mid-abdomen and lower-abdominal hernia surgery. Despite gross obesity, it is usually technically feasible if one has high grade equipment as most abdominal obesity is WITHIN the abdomen and the skin overlying the abdominal wall muscles is very modestly imbedded with adipose tissue.

D. THE FEMORAL NERVE BLOCK IN THE OBESE PATIENT.

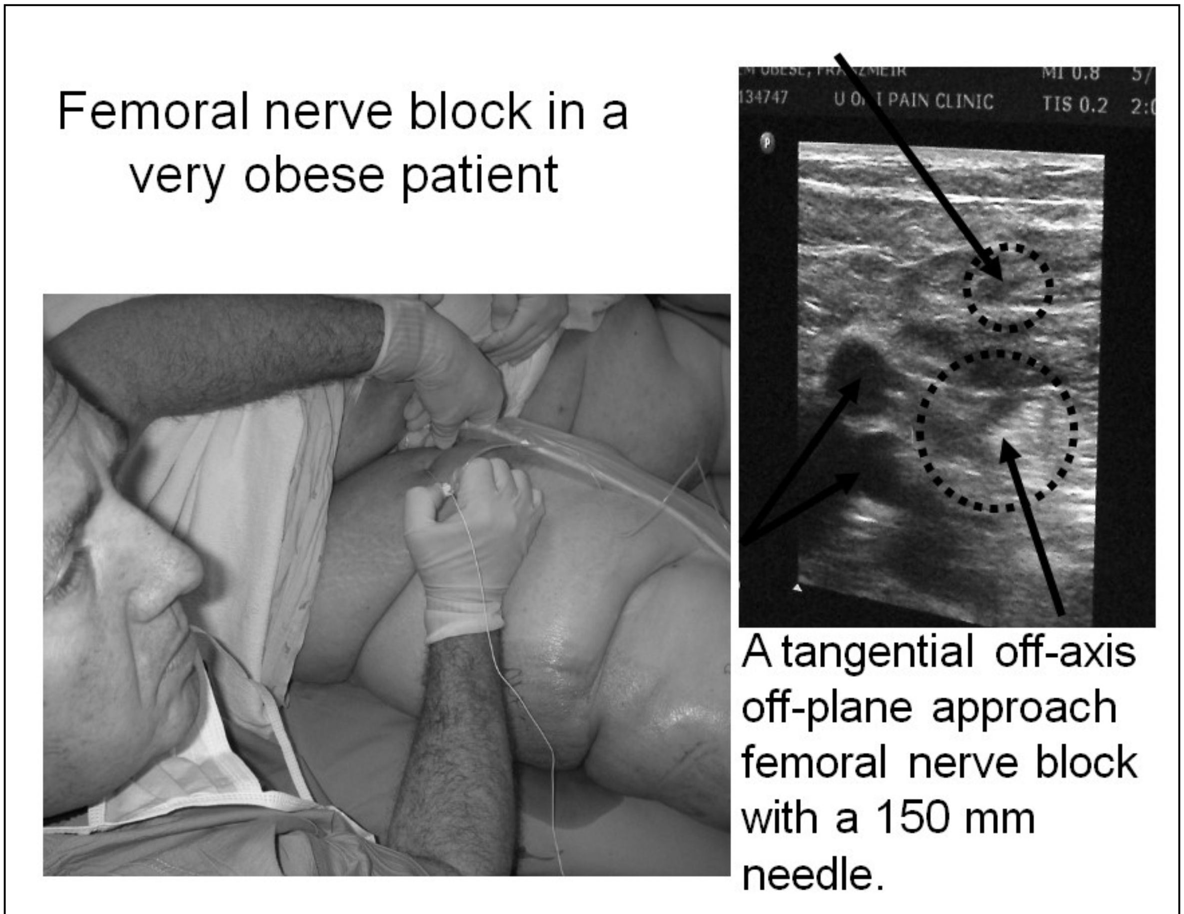




An assistant can retract the abdominal panniculus (pannus) to expose the groin better. One can also use abundant strips of skin adhesive tape to pull the abdomen superfluous fat and skin cephalad towards the arm rail of the cart, to improve the exposure of the groin. Often this is problematic. There are limitations to this technique. The assistant may tire and move too much during the procedure. The assistant is also removed from all other aspects of helping with the procedure. Also, if the pannus was taped away, groin exposure may still be insufficiently close to the inguinal ligament to perform a good femoral nerve block.

This author prefers to insert the linear transducer into the natural skin crease at the patients groin position. This is often 15 cm more caudad than the crease of young thin person. The operator dies not have to hold the transducer tightly as the walls of fat typically fully engulf it so that the transduce is invisible. The transducer is then moved back and forth, medial to lateral to identify the femoral artery.

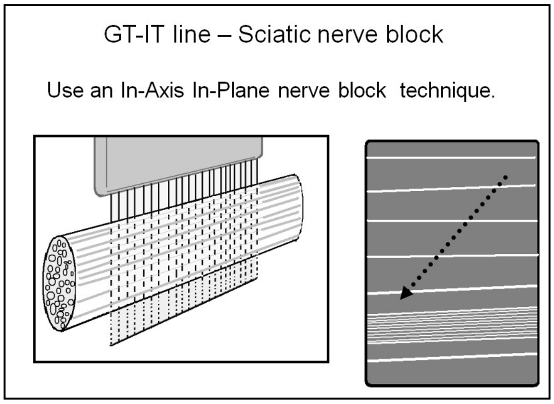
The operator then stands slightly cephalad of the transducer and pulls it towards themselves retracting the pannus slightly. The objective is to get a view of the common femoral artery, and be cephalad to the arterial bifurcation. That represents a level at which a femoral nerve block will be complete. A direct in-plane needle approach or direct out of plane needle approach from direct caudad are impossible with 10 cm needles. However, inserting the needle caudad and lateral from the transducer, allows the needle to make angled off-plane approach. This is this author’s preferred approach due to its speed, ease, and “lack of drama”.

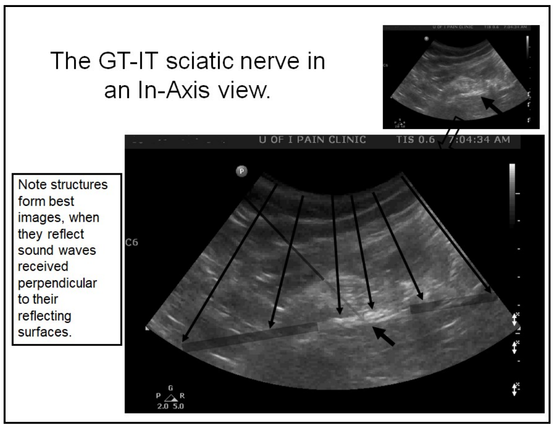


See the ultrasound transducer in the doctor’s left hand. The transducer is nearly out-of-sight deep into the pannus-groin skin crease. Note how the needle is inserted from lateral, caudad and far from the transducer. The needle is then aimed to meet the tissue below the transducer. This is an Oblique off-plane technique. See in the static ultrasound image where the femoral artery lies left of the hyperechoic femoral nerve in the lower circle. The upper circle shows the distortion in the tissues as the needle tip just enters the ultrasound image plane. The needle is much more easily recognized using slight back and forth movement with a dynamic Live” video image. This is reasonably easy to do, if one is trained in the off-plane nerve block technique.

Withdraw the needle to lose it in image, plus another 5 to 10 mm. Then redirect the needle tip aiming closer to the big femoral nerve and re-advance the needle. A nerve stimulator set at 1Hz twitches and 0.5 mAmp will indicate when the needle touches the femoral nerve. One will also see the needle touch the femoral nerve. This block is easier than what it may seem, in this description.

E. SCIATIC NERVE BLOCKS IN THE BUTTOCK REGION.

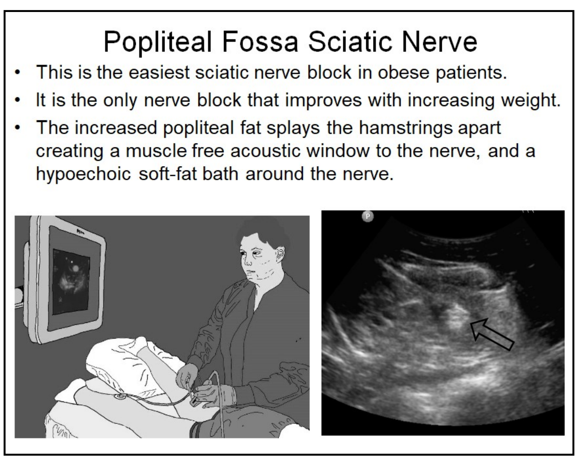




Performing a sciatic nerve block in a morbidly obese patient can be entirely impossible due to the nerve lying 20 cm deep. Inspection first is still worthwhile. There is great variation in fat distribution in obese patient's buttocks between different individuals. Sometimes the sciatic nerve may be only 5 cm below skin. Both nerve stimulator guided (up to 16 cm deep) and ultrasound guided (up to 8 cm deep) GT-IT line sciatic nerve blocks have been achieved by this author. More often than not it is not worth trying.

The GT-IT line sciatic nerve is best viewed using a in-axis view, and the needle is best inserted using an in-plane view. Viewing a 6 cm deep nerve may be near impossible with an off-axis view, but when using the in-axis view it becomes much more visible for about a 3 to 5 cm length. It takes a steady hand and good technical experience to perform a deep in-plane in-axis nerve block, but it is feasible.

F. SCIATIC NERVE IN THE POPLITEAL FOSSA.

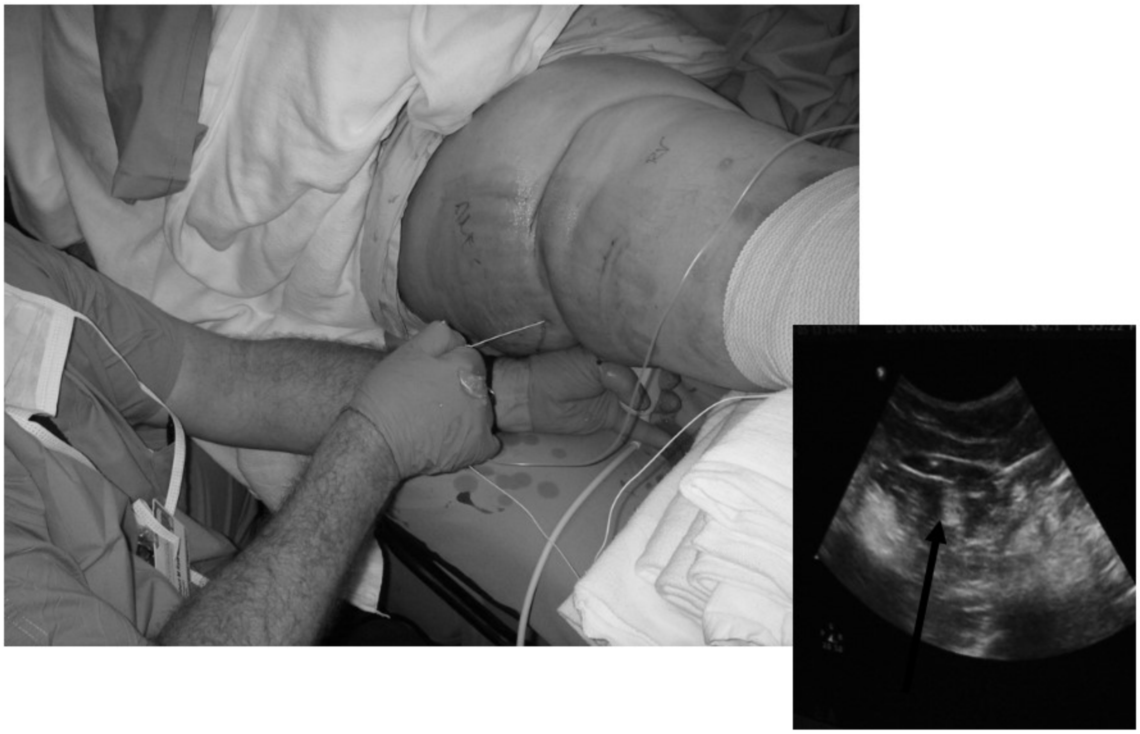


The sciatic nerve block in the popliteal fossa is one nerve block that actually gets a bit easier with slight obesity as the fat splays the popliteal fossa wider pushing the hamstring muscle to the side creating a larger acoustic window. The sciatic nerve also becomes hyperechoic and more visible. This author has never seen a difficult obese popliteal sciatic nerve block in patients even up to a BMI of 60 and weighing 300 kg.

- One has to adapt patient positioning to what the patient can easily achieve or tolerate. Usually this is best done with the patient remaining supine and one lifting the ankle and mid-calf on boxes or folded blankets. In addition, one should strap the leg to the bed to make it less "wobbly". The transducer can then be placed under the leg behind the popliteal fossa and an "upside down" nerve block done.
- The saphenous which is commonly performed as paired nerve block with popliteal sciatic can be simply blocked in the distal medial thigh as sub-

sartorius muscle saphenous nerve block in a plane about 3 cm cephalad to the upper pole of the patella.

Popliteal fossa sciatic nerve block, in an obese patient.



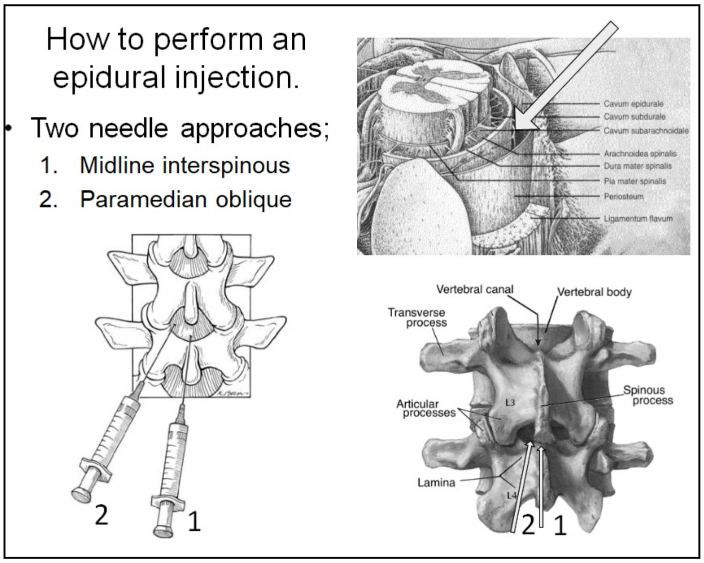
A super-obese lady lying supine (face-up) undergoing a popliteal fossa ultrasound-guided sciatic nerve block. The foot and calf have been raised off the bed with folded blankets. This creates space behind the popliteal fossa, above the bed. A transducer can be placed in to that space behind the knee, to guide the nerve block needle. Insert the needle from lateral.

It does take a few moments to re-orientate oneself as to which direction to move the needle in your hand, to determine how it will move in the sonogram.

This female patient weighed 275 kg and had a body mass index (BMI) of 101. She received a femoral nerve block to cover the saphenous nerve, and a popliteal fossa sciatic nerve block. The foot surgery was performed awake. The tourniquet was placed on the upper calf region. She received no sedation for the procedures of the nerve block, or the foot and ankle surgery. She was positioned in a semi-sitting position. She could not lie flat for longer than single minutes without being overwhelmed by difficulty breathing. The surgeon was supportive of the anesthesia plan and the anesthesia team. (Photos are used for educational purposes with signed patient permission.)

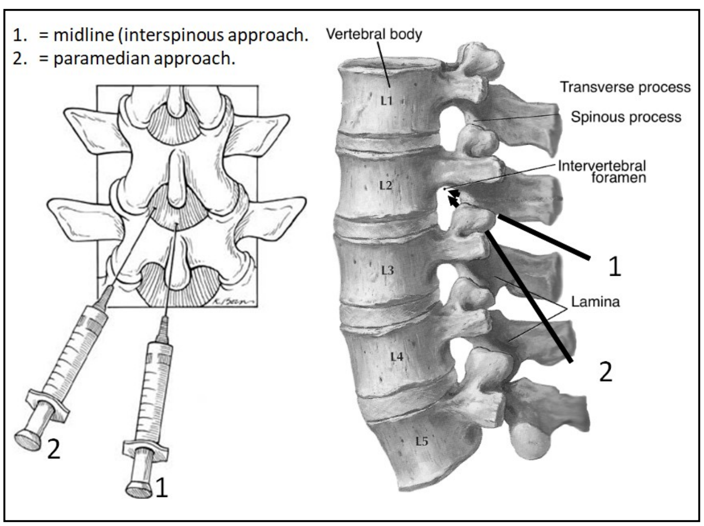
8. USE OF THE ULTRASOUND WITH EPIDURAL BLOCKS

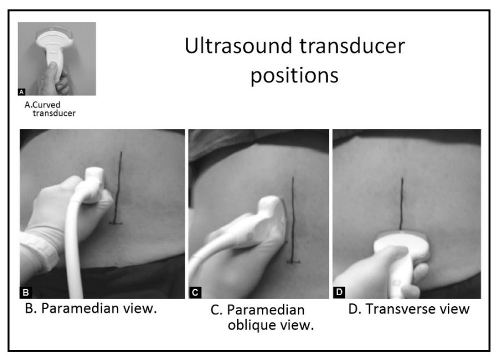
The ultrasound can be used in two ways with epidural blocks in the lumbar region. The first method is called an *ultrasound-<u>aided</u>* epidural block. The ultrasound is used only for a pre-scan to identify the midline and mark it on the skin. The ultrasound can also be used to identify the levels of the vertebra. The actual epidural block is then performed without the ultrasound.

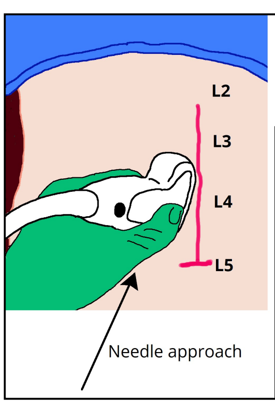


The second method is called *ultrasound-<u>guided</u> epidural block*. That is a sophisticated technique require both advanced ultrasound equipment experience in regional anesthesia. It also requires advanced experience performing epidural blocks at all vertebral levels.

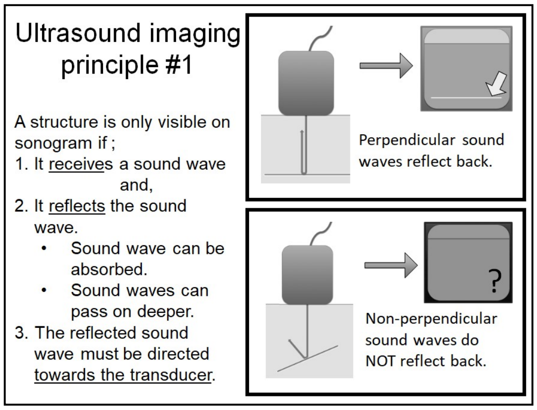
An ultrasound guided epidural is impossible in the midline as the dorsal processes hinder seeing the needle in view in an in-plane approach, as well as an off-plane approach. The only option is then to perform a paramedian approach epidural. The transducer must be held in an angled paramedian oblique view, cephalad to the approaching needle.





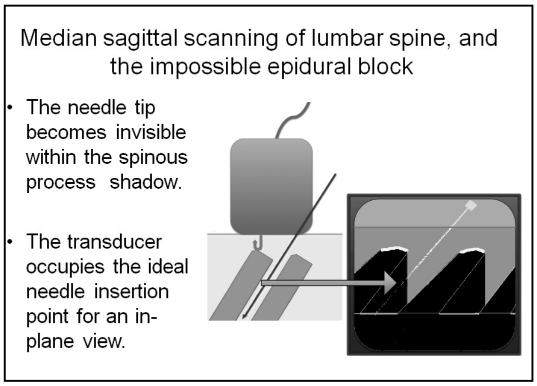


The epidural needle is inserted paramedian aiming cephalad and towards medial. The goal is to meet the epidural space back in the midline, in an interspinous space. An epidural-space meeting-point position a few millimeters to lateral in an interlaminar space is acceptable too. The transducer is held so as to align it with the needle path in an ***angled-paramedian-oblique*** in-plane needle view.



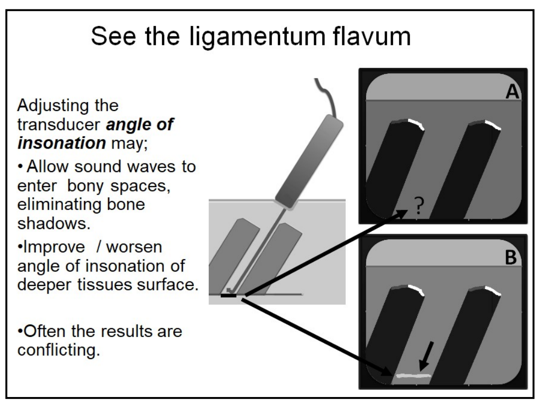
It is now necessary to understand how the ultrasound sees the bony structures of the vertebrae.

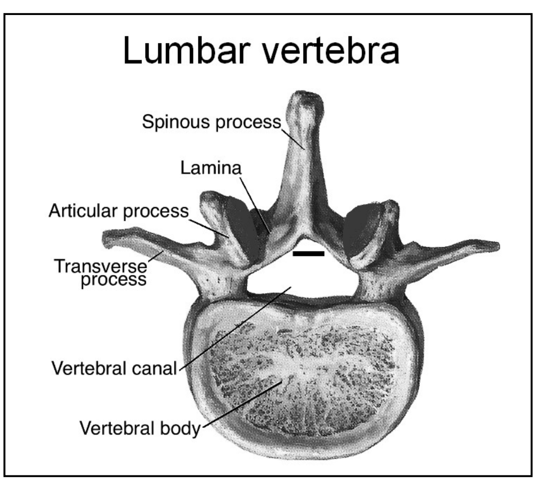
The first key fact is that only bone surfaces aligned so with the transducer so that the sound waves impact with the bone perpendicular, will be observable on image. For an image to form, a transmitted sound wave must bounce direct back to the transducer to be sensed. That means large part of the vertebra is visually lost in a darkness in the sonogram. That can be very confusing to a novice. In order to interpret the sonogram, one must be very familiar with the transverse view of a vertebrae.

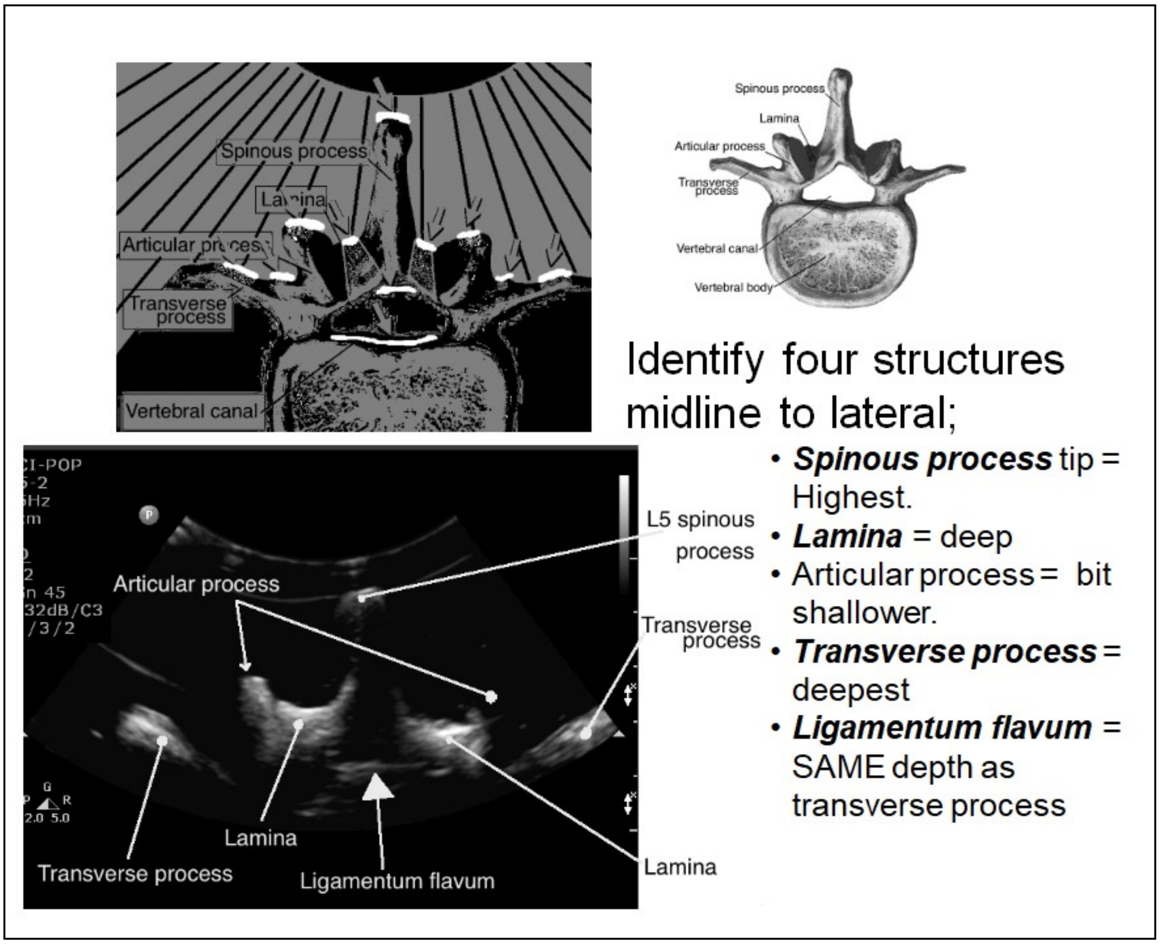


The second key fact is that a sloping bone like a spinous process will create a *sonographic shadow*. The needle can pass into that shadow and be invisible. It is invisible because no sound can reach it to reflect back in order to form an image.

The ligamentum flavum can often be seen when a transverse held transducer is tilted slightly towards cephalad. That lets the transducer “look“ up the interspinous space, where a epidural needle will pass. The normal imaging of the ligamentum flavum is however very poor and it is barely recognizable. That is because the sound waves impinge on it at a very unfavorable angle for being reflected back.



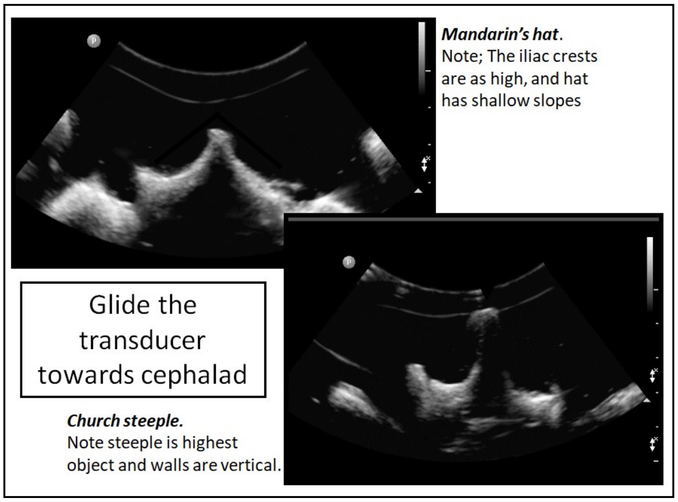




In the image above, matchup the echogenic portions of the vertebra on the sonogram with the drawing of the vertebral body.

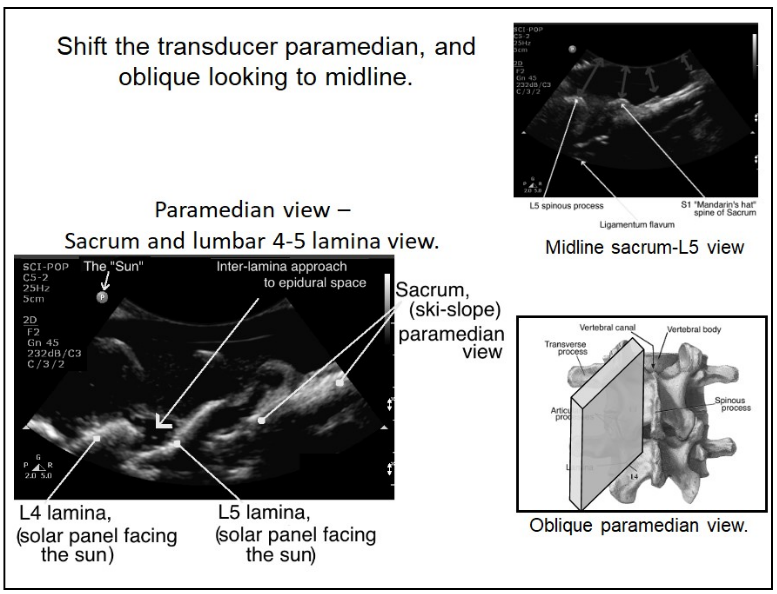
THE THIRD HAND.

As it takes the operator's two and only hands to hold the transducer and the Tuohy needle, a second person has to supply their one hand as the nerve block *third hand.* The third hand has to hold the loss-of-resistance epidural syringe. The syringe cannot be connected to the Tuohy needle directly, lest this assisting extra person bump the needle. Therefore, a thin-line injection-extension must be placed between the Tuohy needle and the syringe. The third hand is responsible for carrying out the loss-of-resistance test. The two persons must coordinate and talk to each other.



To identify the vertebral level of the lumbar region, place a curved transducer in the transverse and then glide it to caudad until the first part of the sacrum is seen. Seek the "Mandarin's hat" sign. Note the shallow side slopes of the hat. Note also that the pinnacle is 1-3 centimeters below the skin. That is S1. Then slowly glide the transducer back towards cephalad. The Mandarin's hat will disappear, and a "church steeple" will appear. That is lumbar vertebral spinous process. Its sides are so steep as to be invisible. Also, the pinnacle is almost touching the skin.

The first steeple is L5. One can then count off the steeples all the way to L1 and mark the skin as needed.

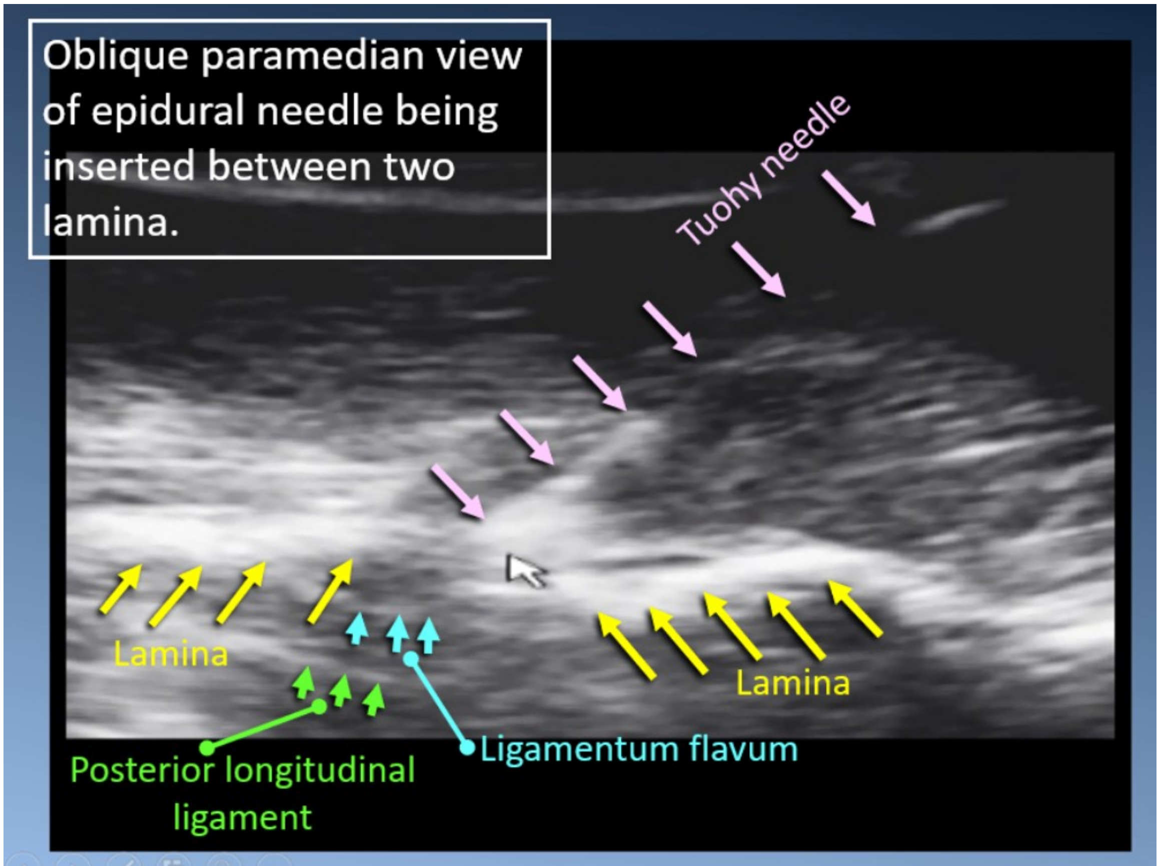


To do the ultrasound guided epidural injection place the curved transducer in the midline in the long axis. Image over the sacrum and see how it lacks intervertebral spaces, being one solid fused bone. The long bone surface is slightly irregular and runs from very shallow, most caudad, to deeper at the sacrum's cephalad upper end. We call that long echogenic surface the "ski slope".

Next, glide the transducer slightly to paramedian at about the L5 level. The long ski-slope is still visible on the caudad side of the image. On the cephalad side 2 or 3 "solar panels" can be seen facing the sun towards the cephalad side. Those are the vertebral laminae. The goal is to pass the Touhy needle in between these laminae, aiming to make contact with the epidural space about midline.

Now, rotate the transducer slightly, so as to point towards the midline. Insert the Touhy needle and advance it in-plane towards the interlaminar space. The ligamentum flavum may be recognized by offering a slight resistance and then popping feel as the needle passes it. Your assistant should report exactly at that moment, a loss of resistance. Pass the epidural catheter and use and test the catheter in a routine fashion.

That is an ultrasound guided lumbar epidural block.



At a quick glance this image seems vague and meaningless. To the understanding eye and intelligent expectant brain, all the information needed is available. The operator's one hand will hold the transducer and the other the needle. A second skilled person will need to hold the loss of resistance syringe connected to an injection extension, connected in turn to the Tuohy needle. The two persons must work slow and with great sensitivity in the fingers holding the needle and in depressing the syringe plunger. The plunger should be continuously depressed, but to a pressure that is just short of moving the plunger. The two persons must communicate continuously to each other about what they feel in the advancing needle and in the syringe, respectively. This is a very advanced regional anesthesia technique.

An ultrasound-guided lumbar epidural block can be done in patients where super-obesity has made the standard blind midline epidural approach fail.

A pregnant lady giving birth to a baby, is the only patient doctors ever treat who is not ill. It is a treatment however, that assists produces a most beautiful moment in life.

9. GENERAL ADVICE IN PERFORMING REGIONAL ANESTHESIA IN THE OBESE.

1. Use longer needles. There is an increased incidence of failure to reach the nerve in all blocks.
2. Position the patient optimally before administering any sedation and analgesia for the procedure.
3. Choose the nerve blocks most appropriate considering the side effects interaction with the obesity associated disease. E.g. avoid potential phrenic nerve blocks and risks of pneumothorax.
3. Choose nerve blocks whose accessibility is best preserved in obesity, even if they are sub-optimal approaches in ideal patients.
4. Don't rush into surgery after the block.
   - **D**elay surgery to maximize soak time. (start the nerve block *further ahead* of surgery scheduled time)
   - **A**ssess the block. It is inappropriate to discover severe block inadequacy for the first time during surgery. (By knowing ahead of time that the nerve block may be inadequate allows for better planning on strategies to deal with that.)
   - **R**escue the block that is identified as inadequate. (Block the slow or lagging nerve component more distally.)
   - **H**ave a rescue plan for a severely inadequate nerve block anyway.

10. SUMMARY.

Sometimes the patient in whom a nerve block seems most impossible, is the very patient who most needs a nerve block. With four things one can always make a good plan for the super-obese patient. (1) Experience. (2) Comprehensive knowledge of the applicable anatomy, particularly of the sectional views. (3) An ultrasound. (4) A creative imagination.

The impossible always seems easy, after it was done.

A review by Michelle Parra (2012) on Obesity and Regional Anesthesia covered the medical anesthesia problems of obesity very well[13].

[1] Stoelting TK. Anesthesia and co-existing disease. 4th Ed. Churchill Livingston, Philadelphia 2002
[2] Lermitte J. Patient selection in ambulatory surgery. Curr Opin Anaesth. 2005;18:598-602
[3] Nielsen KC. Influence of obesity on surgical regional anesthesia in the ambulatory setting: an analysis of 9 038 blocks. Anesthesiology. Jan 2005;102(1):181-187
4 Carles M. An evaluation of the brachial plexus block at the humeral canal using a neurostimulator (1417 patients): the efficacy, safety, and predictive criteria of failure. Anesth and Analg. 2001 Jan;92(1):194-8
[5] Conn RA. Interscalene block anesthesia for shoulder surgery. Clin Orthop Relat Res. 1987 Mar;(216):94-8.
[6] Gatra A. Brachial plexus block and locoregional anesthesia of the upper limb. Apropos of 50 cases. Acta Chir Belg. 1986 Nov-Dec;86(6):344-8.
[7] Schwemmer U. Ultrasound-guided interscalene brachial plexus anaesthesia: differences in success between patients of normal and excessive weight. Ultraschall Med. 2006 Jun;27(3):epub 2006 Mar 16
[8] Hanouz JL, et al. Multiple injection axillary brachial plexus block: influence of obesity on failure rate and incidence of acute complications. Anesth Analg 2010 July;111(1):230-233
[9] Hodgkinson R. Obesity, gravity and spread of epidural anesthesia. Anesth and Analg June 1981;60(6):421-424.
[10] Werner RA. Influence of body mass index on median nerve function. Carpal pressure, and cross-sectional area of the median nerve. Muscle Nerve. 2004 Oct;30(4):481-56.
[11] Moore JH. The biophysical effects of ultrasound on median nerve distal latencies. Electromyogr clin Neurophysiol 2000 Apr-May;40(3):169-80.
[12] Cosentino AB. Ultrasound effects on electroneuromyographic measures in sensory fibres of the medial nerve. Phys Ther. 1983 Nov;63(11):1788-92.
[13] Parra Michelle, et al. Obesity and Regional Anesthesia. Int Anes Clinics. 2013;51(3):90-112