Ultrasound Guided Single Injection Femoral Nerve Block

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OBJECTIVES
Welcome to Ultrasound Guided Single Injection Femoral Nerve Block.

Video Objectives:
- Define important gross and ultrasound anatomy
- Describe an in-plane technique for needle insertion
- Distinguish between successful and unsuccessful spreads of local anesthetic
- Identify potential challenges and pitfall errors associated with performing this block

EQUIPMENT SPECIFICATIONS
Equipment Specifications:
- Linear transducer with frequency of 8 MHz or greater
- 50 mm nerve block needle
- Ultrasound transducer cover and skin antiseptic
- Sterile ultrasound transmission gel
- Appropriate monitors and personnel

GROSS ANATOMY
Gross Anatomy:
- The femoral nerve originates from the ventral nerve roots of the L2 through L4.
- The femoral nerve descends between the psoas major muscle and the iliac muscle behind the iliac fascia.
- It runs beneath the inguinal ligament, lateral to the femoral artery, and then splits into an anterior and posterior division.

Critical Background Information:
In the infrainguinal region, the femoral nerve is not in the same anatomical compartment as the femoral artery. Therefore, this block should not be considered a perivascular block as is true for axillary brachial plexus in which the axillary artery is considered to be a marker for the correct neural anatomical compartment.

Here we see a cartoon indicating infrainguinal anatomical structures.
“SM” is the sartorius muscle.
“FN” is the femoral nerve.
“FA” is the femoral artery.
“FV” is the femoral vein.
The star indicates the key anatomical structure known as the fascia iliaca that contains the femoral nerve.
“L” stands for lymphatics.

We will demonstrate in the future slides the importance of the fascia iliaca and a critical reference structure to generate successful femoral nerve blocks.

Here is an unlabeled image of a dissected cadaver revealing the inguinal structures. Next, the labels are applied. Screen-left is lateral; the top of the screen is proximal; the bottom of the screen is distal.
“FA” is femoral artery.
“FN” is femoral nerve.
“IPM” is iliopsoas muscle.

Note that the saphenous nerve is a branch of the femoral nerve.
The green arrows indicate the critical structure previously described as the fascia iliaca.
Of interest, the obturator nerve is seen on screen-right. It is more medial than the femoral nerve. “ON” stands for obturator nerve.

Here is a close-up of these structures.

**ULTRASOUND ANATOMY AND IN-PLANE TECHNIQUE**

The in-plane for performing a femoral nerve block:
- Place the transducer in the inguinal crease.
- The first objective is to image the femoral artery in short axis.
- Next define the femoral nerve as a distince hyperechoic circle or oval lying 1-2 cm lateral to the femoral artery.

This is a typical set-up for performing a single injection in-plane femoral nerve block.

Here is an unlabeled image demonstrating the sonoanatomy of the right inguinal region. Here is the labeled image.

“IPM” is the iliopsoas muscle.
“FN” is the femoral nerve.
“FA” is the femoral artery.
The fascia lata is labeled.
The skin is labeled.
And screen-left represents the lateral aspect of the patient.

For convenience and reference we have included an image demonstrating the gross anatomical structures as they correlate to the sonoanatomical structures.
With all of these structures identified, scan your anticipated needle trajectory with color Doppler to rule out any unsuspected vascularity. Insert your needle from the lateral aspect of the transducer roughly at a 45 degree angle. The fundamental objective is to have the needle puncture through the fascia iliaca.

In the following videos, we want to emphasize two key points. The fascia iliaca is the key reference structure. Try to learn patterns of local anesthetic spread that predict success versus failure of the block.

Here is a close-up image of the fascia iliaca. Please note the openness of the space lateral to the femoral nerve.
“IPM” is the iliopsoas muscle.
“FN” is the femoral nerve.
“FA” is the femoral artery.
The forceps is actually grasping the fascia iliaca and lifting it up.

Here is another example of a cadaver in which a scissors has been placed under the fascia iliaca over the iliopsoas muscle. This is the space where catheters of local anesthetics will travel.

Here is an example in which a probe is inserted under the inguinal ligaments under the femoral nerve to demonstrate the course of the femoral nerve as it travels towards the lumbar plexus.
“IM” stands for iliacus muscle.
“PM” stands for psoas muscle.
“ASIS” stands for anterior superior iliac spine.
“FN” stands for femoral nerve.
This is an example of a patient in which a catheter was placed at the site of the inguinal region. The catheter was advanced approximately 20 cm. The contrast study was taken demonstrating the final location of the catheter up by the lumbar vertebral bodies. This would be an affective lumbar plexus block.

The following is an example of a single injection right-sided femoral nerve block. Here is the anatomy:

Screen-left is lateral.
“FA” is femoral artery.
The fascia lata is the first hyperechoic layer.
The femoral nerve is demonstrated in yellow.
The needle is inserted, coming in from screen-left. The needle is seen puncturing underneath the fascia iliaca. Watch the local anesthetic come out. The first injection is intramuscular. The needle is slightly withdrawn and the correct spread of local anesthetic is noted. There is usually a characteristic left-right spread of local anesthetic when the needle is under the fascia iliaca and not intramuscular.

The next example is of a left-sided single injection femoral nerve block. Notice that the operator uses pressure, alignment, rotation, and tilting to optimize the image quality. Next a skin wheel is raised using a 25 gauge needle and the needle is inserted using the in-plane needle insertion technique.

**FASCIA ILIACA BLOCK**

It should be emphasized that the needle can be inserted at a significant distance from the femoral nerve and a strong block still resulting. This is because it is the local anesthetic spread under the fascia iliaca around the nerve that is the critical endpoint.

Here we see the ultrasound image of the left inguinal region.
“FA” is femoral artery.
White arrows indicate the fascia iliaca.
Notice that the nerve is somewhat difficult to visualize contained within the yellow line.
The large arrow indicates the local anesthetic coming out of the needle. Notice how the local anesthetic spreads medially to surround the femoral nerve. Once local anesthetic is around the femoral nerve, it is easy to appreciate the nerve and even some of the fascicles around the nerve.

VARIATIONS IN SPREADS OF LOCAL ANESTHETIC
The following video is an example of the circumferential spread of local anesthetic around the femoral nerve. This spread of local anesthetic is sometimes referred to as the donut sign. Although the donut sign is not necessary to achieve a successful block, it certainly does result in a profound block. The local anesthetic is hypoechoic and black and can be seen surrounding, completely, the femoral nerve.

The following example demonstrates how a femoral nerve can get displaced is a posterior direction with the injection of local anesthesia. Here is a shot after the injection. The femoral nerve is seen as a hyperechoic oval indicated by the yellow area. The local anesthetic is indicated by the white outline. The femoral artery is indicated as red, screen-right. Screen-left is lateral.

It should be noted that it is not necessary that you get complete circumferential spread of local anesthesia around the nerve for the block to be successful. Here is the displacement of the femoral nerve in real time. Note that this block was highly successful for postoperative __________ in this particular patient.

EXAMPLE OF INCORRECT INJECTION
It is important to distinguish between incorrect and correct injections. In the following example, an out-of-plane technique was utilized so the operator should not expect to see the full shaft and needle tip. What you are about to see is that the local anesthetic
when first injected goes into this yellow area that we have identified as “no man’s land.” This is an area where the block will not be successful. The arrow indicates the local anesthetic first being injected here. The with the needle tip being advanced further, the correct spread of local anesthesia is noted.

**PITFALL ERRORS**
Possible pitfall errors:
- Intravascular injection
- Intraneuronal injection
- Injection above fascia iliaca (no man’s land)
- Needle insertion through lymph node

Here is an example of a large lymph node located in the right inguinal region as seen by ultrasound.
“LN” stands for lymph node.
This is a typical appearance of a lymph node, a hypoechoic round or oval structure. The major technical issue here is that the operator is unlikely to want to insert a needle or catheter into this structure. Therefore the knowledge of the location of the lymph node is helpful in needle insertion.

**ASRA RECOMMENDATIONS**
The following points were discussed in detail in the McGraw-Hill's Introductory Ultrasound Guided Regional Anesthesia. However, it is important to emphasize that the American Society of Regional Anesthesia recommends that
- If nerve swelling is identified during injection, the injection should be aborted
- If the local anesthetic is not visualized, the operator should assume the needle is intravascular and therefore should be repositioned.
- Prior to needle insertion, the operator should confirm that he/she knows what part of the body correlates to the left side of the ultrasound screen. This correct orientation will
allow the operator to focus his/her attention on the screen area in which the needle will be first visualized as it enters the patient.

**SUMMARY**

In summary:
- The key to a successful femoral nerve block is to confirm the spread of local anesthetic occurs below the fascia iliaca.
- The operator’s needle can be a considerable distance away from the nerve and still achieve a complete block.
- The author prefers the in-plane approach.
- Be on the look out for intravascular and intraneuronal injections.