Nerve block of lateral femoral cutaneous nerve of the thigh

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INDEX

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1. INTRODUCTION

This chapter is intended primarily for use by anesthesiologists. There is some information of interest to surgeons. The lateral femoral cutaneous nerve of the thigh (LFCN) is probably the single peripheral human nerve most subject to anatomic variations[1]. The biggest key to success in blocking this nerve is understanding the anatomical variations involved. The recommended nerve block techniques in this chapter will therefore be those most suited for satisfying the priorities of (1) expeditious time performance of the nerve block, (2) high level of patient safety, (3) minimized patient costs, and very importantly, (4) 100% nerve block success rates. See figure #1 for the basic typical anatomy of the LFCN in the groin.

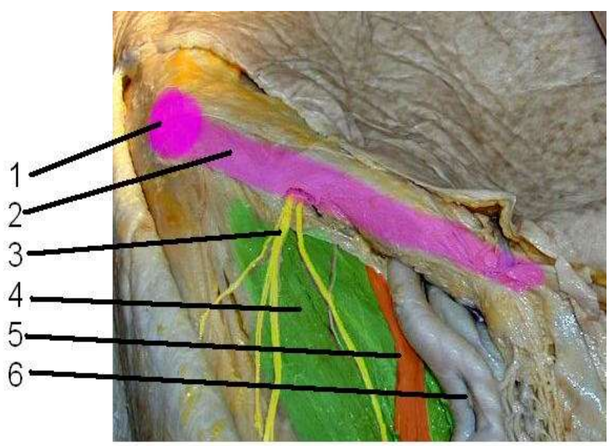

Figure #1. Groin region cadaver dissection. The fascia iliaca has been dissected off.
1. Anterior Superior Iliac spine (ASIS),
2. Inguinal ligament (pink color),
3. LFCN (yellow color),
4. Sartorius muscle (green color),
5. Femoral nerve (red color),
6. Femoral artery and vein.

Chronic pain therapy physicians intending to perform diagnostic nerve blocks or lytic blocks for chronic pain syndromes, might be justified in spending a large amount of time using precision localization techniques combining ultrasound visual guidance and nerve electrostimulation to identify the nerve visually and precisely. That will be costly and time consuming and is unsuitable for perioperative patient care. acute pain therapy perioperative regional anesthesia physicians however do not actually need to see the lateral femoral cutaneous nerve in order to inject it effectively. They only need to identify the four tissue space-planes that could contain the Lateral Femoral Cutaneous Nerve of the Thigh (LFCN) in its variant forms.

The nerve is relatively small compared to, for example the sciatic nerve, and is rarely noticed with quick ultrasound examination. It can however often be visualized in young and thin patients' ultrasound imaging. The examiner should manipulate the transducer slowly and skillfully, and have an experienced studious observer's eye. Actually, seeing the nerve is however not necessary to perform effective ultrasound guided LFCN blocks.

There are four common surgeries in the region of the LFCN that are associated with injuries to the LFCN. They are (i) iliac crest bone harvest, (ii) inguinal hernia repairs both open and endoscopic, (iii) wide obstetric-gynecological Pfannenstiel incisions and (iv) the anterior-approach total hip arthroplasty. Injury to the nerve has been observed in 2% of hernia repairs, and 80% of total hip arthroplasty cases surgeries. Surgeons trying to avoid injury to the LFCN must either (a) diligently expose the nerves by dissection during surgery, or

(b) alter their technique and site of incision to avoid the LFCN. Surgery can injure the nerve by accidental section, unseen ligation of the nerve, or retractor induced stretch damage.

To the regional anesthesia practitioner seeking to inject drug onto the LFCN the high incidence of anatomic variation can cause a nerve block failure rate of 30 to 50% if drug is injected in small volumes at one point only.

This nerve has previously been called the lateral cutaneous nerve of the thigh (LCNT), but its current modern name is the lateral femoral cutaneous nerve of the thigh (LFCNT) or just LFCN.

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2. ANATOMY

The lateral femoral cutaneous nerve is a sensory nerve supplying the skin on the lateral aspect of the thigh. It is expected that typically, with a complete LFCN block, skin sensation loss will (i) extend distally on the lateral aspect of the thigh to near the same height as the proximal border of the patella, (2) towards posterior but not reaching the midline, (iii) towards anterior but not reaching the thigh midline, and (iv) towards cephalad on the lateral aspect passing over the greater trochanter but not reaching the greater trochanter. See figure #2.

The typical LFCN is a branch of the lumbar plexus deriving from the dorsal divisions of nerve roots L2 and L3. See figure #3. The LFCN forms within the psoas muscle and emerges from the lateral border of the psoas major within the pelvis. Next the LFCN runs obliquely inferolateral crossing the iliacus muscle under the fascia iliaca. It runs further, in an infero-lateral direction, towards the anterior superior iliac spine (ASIS) passing it on its anteromedial side. It then passes under the inguinal ligament, and over the sartorius muscle. In the thigh it remains under fascia lata until after its final anterior and posterior divisions branches are formed which finally become subcutaneous. The anterior branch becomes superficial to fascia lata about 10 cm below the inguinal ligament, and divides into branches which are distributed to the skin of the anterior and antero-lateral aspects of the thigh, as far caudad as the knee. The terminal filaments of this branch frequently communicate with the anterior cutaneous branches of the femoral nerve, and with the infrapatellar branch of the saphenous nerve, forming the peri-patellar plexus. The posterior branch of the LFCN also pierces the fascia lata becoming subcutaneous about ten centimeters beyond the inguinal ligament, and subdivides into filaments which pass backward across the

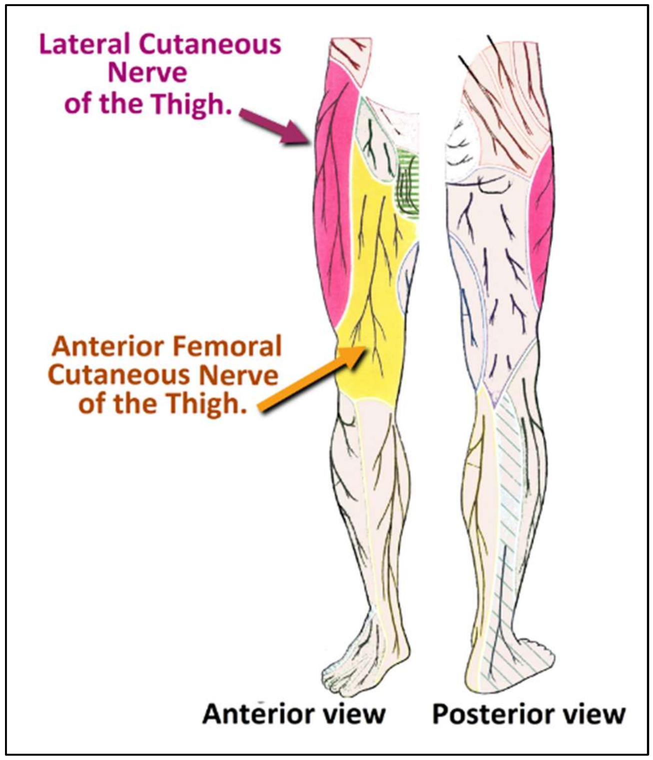


Figure 2. Classic dermatomal distribution of the lateral femoral cutaneous nerve (LFCN), derived from Sobotta.

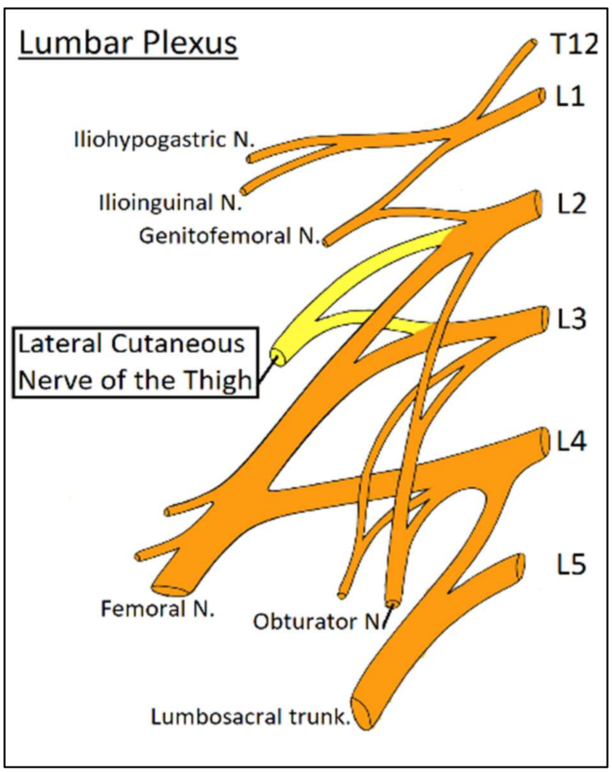


Figure #3. The lumbar plexus giving origin to typical LFCN (color yellow) with roots L2-3.

postero-lateral and posterior surfaces of the thigh, supplying the skin over the greater trochanter to the middle of the postero-lateral thigh.

When the nerve is unintentionally injured it is possible if early branching has occurred to only injure one branch and get a smaller area of loss of sensation. With nerve blocks if early branching occurs and a small volume injection is made at one point only, the nerve block could be incomplete due to only blocking one branch. Also, if using poor technique and excessive drug volumes, secondary adjacent sensory nerves may be included LFCN block causing an exaggerated impression of the sensory distribution of the LFCN. See figure #4 illustrate this point.

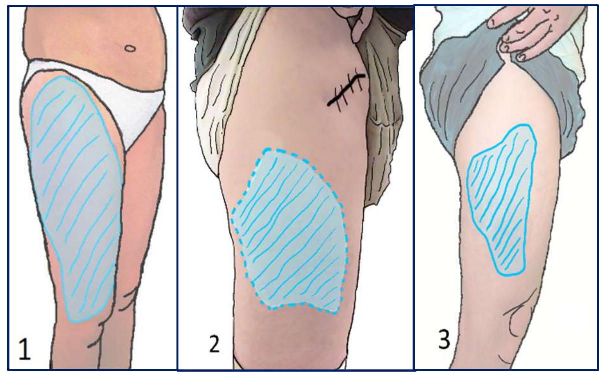


Figure #4. Three patients with seemingly different LFCN dermatomes. Subject #1 has an unusual anterior spread of sensation loss due to an unusual technique with drug spread onto the anterior femoral cutaneous nerve. Subject #2 lost sensation in only part of the LFCN area following an anterior approach hip joint replacement. Likely only the anterior branch of LFCN was injured. Subject #3 also has no skin sensation loss over his greater trochanter after nerve injury, also likely reflecting an anterior branch LFCN injury.

3. ANATOMICAL VARIATION

The foremost anatomical characteristic of the LFCN is the high frequency and wide variety of its anatomical variations. As few as only 60% of patients have a LFCN considered as fully typical over its entire course. This fact creates challenges for surgeons who seek to never injure the nerve. It also challenges anesthesiologists who seek to block the full nerve. Many dissection studies have been done each with a targeted focus pertinent to one particular surgery in one particular site. Many studies omit some critical description that other practitioners are specifically interested in. Study results also vary according to the genetic origins of the population majority under study. The total of all study results is more meaningful, as the 2016 Meta-analysis of Tomaszewski reflected, but that study is still limited by it focusing on anatomical aspects of interest to mainly surgical inguinal hernia repair[1].

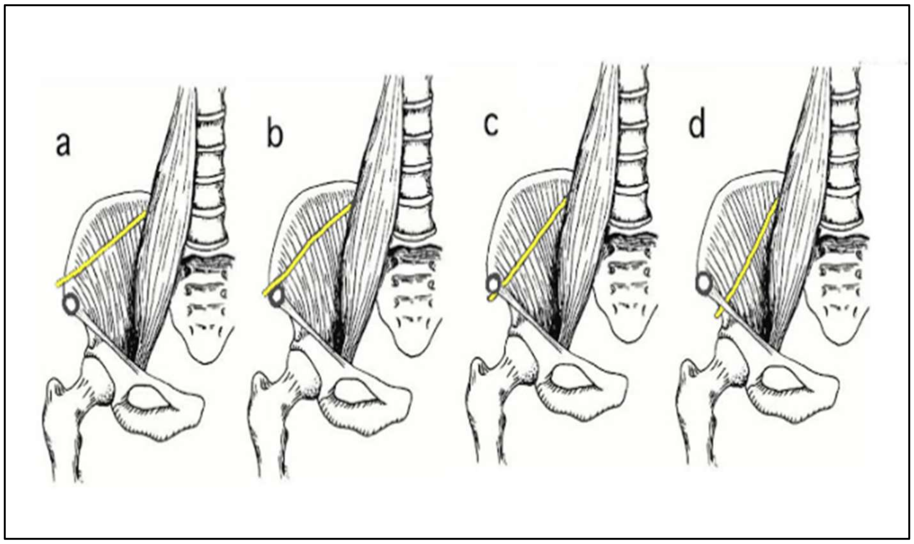


Figure #5. The relation of the LFCN to the anterior superior spine classified by Murata. The ASIS is a palpable reference point potentially indicating risk zones and distances from which to exceed during surgical interventions. This could protect the LFCN from surgical injury.

Murata dissected 216 Japanese cadavers finding that the LFCN *pelvic exit* passed relative to Antero-Superior Iliac Spine (ASIS) as follows[2]; (Figure #5)

A. Far postero-lateral to ASIS (more than 2cm back) - 2%.
B. Close postero-lateral to ASIS (within 2 cm from ASIS) - 11%.
C. Close antero-medial (within 4 cm distance from ASIS) – 29%.
D. Far antero-medial (more than 4 cm distance from ASIS) – 58%.

In another 44 dissections Bjurlin found in American cadavers the LFCN passed medial to ASIS and under the inguinal ligament in 100% of dissections, at a mean distance medial to the ASIS of 2.6 cm (range 0.3 cm to 6.5 cm)[3].

In 34 German cadaver dissections Mischkowski found a cadaver with one branch of LFCN passing postero-lateral to the ASIS and the other antero-medial[4]. Both branches were with 5 millimeters respectively, of ASIS. Their study never saw the entire LFCN pass posterolateral to ASIS. No other researcher had until then ever noted a nerve pass BOTH medial and postero-lateral to ASIS with different branches. The balance passed medial to ASIS under the inguinal ligament, and on average 1.5 cm medial to the ASIS in an infero-medial direction.

One American study by Grothaus, of 58 dissections, found the LFCN exited the pelvis and entering the thigh under the inguinal ligament in all cases[5]. The distance to medial of the LFCN when it passed ASIS ranged from 6 to 73 millimeters. After passing the inguinal ligament the

LFCN swing toward lateral and completed crossing the sartorius muscle lateral edge, typically, 5 centimeters caudad to the ASIS. Branching into the posterior and anterior branches took place after the lateral edge of sartorius is crossed in 72% of cases. In the other 28% of the dissections LFCN *branched* before exiting the pelvis and passing under the inguinal ligament. The importance of branching means if one identifies the LFCN at surgery one can never be sure there are not more still undiscovered branches.

The typical LFCN only branches into two limbs, but variant nerves may however have three, or four or five branches. The Grothaus study investigators did not dissect lateral to ASIS as their interest was potential nerve injury in the inguinal zone, and therefore we cannot say they excluded existence of LFCN branches crossing postero-lateral to ASIS in their 58 dissections.

Aszmann's dissection of 104 nerves classified LCNT positions as[6];

A. Passing posterior to the ASIS (4%)
B. Passing anterior to the ASIS superficial to Sartorius (27%).
C. Passing immediately medial to ASIS but penetrating the sartorius tendon-muscle (23%).
D. Passing close medial to ASIS and then deep-medial to sartorius before crossing back superficial to sartorius to the medial edge before turning back to towards lateral still superficial to sartorius.
E. Passing far medial to ASIS and far medial to sartorius before crossing superficial to sartorius towards lateral about 5- 10 cm caudad to ASIS. (20%). This variant gives a branch to the genito-femoral nerve.

The LFCN was dissected in 40 Brazilian cadavers by Da Rocha. In all cases it passed medial to ASIS and 70% had three large branches and 30% had 2 large branches[7]. The LFCN has been measured immediately below the inguinal ligament to average 2.25 mm across and 0.79 mm thick[8].

The thorough Dutch dissection of 200 fresh cadavers (400 nerves) by De Ridder looked at how the LFCN left the pelvis and entered the thigh[9]. Table 1a is a classification of those findings derived from De Ridder's data. Types I to IV formed 90% of the lateral femoral cutaneous nerves of the thigh (LFCN) entering the thigh from the pelvis. Those nerves all entered the thigh in proximity to the upper sartorius muscle and under fascia lata. The remaining LFCN nerves, and other adjacent nerves that in the absence of true LFCN that supply the lateral thigh skin zones all lie above fascia lata at some point in their course near the proximal sartorius muscle. Adjacent nerves to the LFCN that on occasion substitute for the LFCN partially or fully are (1) the anterior femoral cutaneous nerve, a branch of the femoral nerve, (2) the subcostal nerves, (3) the ilioinguinal nerve, and (4) the genitofemoral nerve. De Ridder's 400 dissections determined that the LCNT is mostly of L2 and L3 origin with L2 being dominant, but sometimes from the 1st and 2nd lumbar roots in a *pre-fixed* lumbar plexus[9]. Sometimes the LFCN derives from L3 alone or even from L3-4 with a *post-fixed* lumbar plexus. The LFCN can also derive solely from L2. See table 1 a.

Type	Anatomical path of Lateral cutaneous nerve of thing (LCNT)	% of dissections
I	Medial to ASIS, under inguinal ligament, under fascia lata, over sartorius ("Normal").	75
II	Medial to ASIS, through inguinal ligament, under fascia lata over sartorius. ("normal" for nerve blocks)	10
III	Medial to ASIS, under inguinal ligament through sartorius tendon onto anterior surface of sartorius, under fascia lata. ("normal" for nerve blocks)	3
IV	Medial to ASIS, under inguinal ligament, under sartorius to appear lateral besides sartorius under fascia lata. ("normal" for nerve blocks)	2
V	Anteriorly or posterior over ASIS, above fascia lata appearing lateral to plane of sartorius	7
VI	Absent LCNT, or lateral thigh sensation supplied via femoral nerve, ilio-inguinal nerve or multiple nerves.	3

Table 1a. Classification of LCNT entry points into the thigh from the pelvis, modified from De Ridder[9].

These above-mentioned studies show the fraction of LFCN that do not enter the thigh under fascial lata. The varying numbers of observed LFCN passing posterior to ASIS ranged from zero percent to thirteen percent may be due a combination of (1) the smaller studies having insufficient numbers to observe the infrequent "posterior" to ASIS nerves, (2) ethnic-genetic differences in cadavers, or (3) due to insufficient dissection accuracy. Also, some of the studies did not dissect posterior to ASIS to look for the LFCN. Nearly all these studies were done by surgeons with an interest of nerve injury related to whether they did inguinal hernia repairs, hip fracture, or pelvic bone surgery. It is nerve passing to ASIS than are most likely to be injured by iliac crest bone harvesting.

In summary the likelihood of a posterior LFCN existing in a person seems to be about 10% with another 3% of cases having an absent LFCN, and getting the lateral skin of thigh supplied by accessory branches for the femoral nerve, genitofemoral nerve and other "inguinal" nerves. Of importance many persons with unusual nerve supplies to their lateral thigh skin have their nerves lying subcutaneous and above fascia lata. One useable consistent factor is all the nerve pass close to the proximal sartorius muscle all be it in a variety of facial planes. This fact is important for nerve block techniques.

4. OTHER RELEVANT ANATOMY

B1. Fascia lata in its upper lateral origin attaches to the outer margin of the iliac crest, to ASIS, and along the inguinal ligament. The small number of LFCN that pass postero-lateral to ASIS and over the iliac crest will lie SUPERFICAL to fascia lata. All variants of LFCN that pass medial to ASIS and under the inguinal ligament lie DEEP to Fascia lata for a distance up to 5 to 11 cm caudad to ASIS. This implies the posterior variants can be blocked with a subcutaneous infiltration across the path of the nerve.

B2. Sartorius muscle tendon inserts into ASIS. ASIS being a palpable land mark helps locate the sartorius muscle. The muscle is between 2 to 5 cm wide, and is triangle shaped with the wedge side deepest. It runs diagonally across the thigh to insert into the medial aspect of the tibia just below the tibial plateau. It is at all time superficial in the thigh and below fascia lata. It is readily recognized on ultrasound image or may be located at a point 2.5 cm inferomedial to ASIS. Occasionally on ultrasound imaging it reveals a double muscle, one above the other. This is an evolutionary throw-back to the fact that four legged animals have two sartorius muscles.

In upright bipedal animals, as humans, the two sartorius muscles fuse into one and the muscles become relatively rudimentary. In quadrupedal animals the LFCN equivalent passes in between the quadrupeds' pair of sartorius muscles. In upright walking bipedal humans, the two sartorius muscles fuse into one rudimentary muscle and it is this evolutionary history that explain why the LFCN sometimes lies within the sartorius muscle. Rarely the Sartorius muscle is fully absent. At the most proximal part of sartorius the adjacent muscle to lateral the tensor fascia lata. At that point deep to sartorius is seen the round tendon origin of rectus femoris attaching to the Anterior Inferior Iliac spine (AIIS). Looking to medial one sees the iliopsoas muscle. See figure #12.

B3. The Anterior <u>Inferior</u> Iliac Spine (AIIS) is deceptive and easily mistaken for ASIS. AIIS lies half way between ASIS and the upper margin of the acetabulum. This misidentification will cause the tendinous origin of Rectus Femoris muscle which inserts into AIIS to be mistaken for Sartorius muscle and it will also cause the injection points to be too distal and too lateral. This occurs when AIIS is unusually prominent, and when it is palpated with palpating fingers approaching from inferior. This is tempting to do when the abdomen tends to be large and pendulous, but invites an error. The solution is to always rather always seek to palpate the ASIS with palpating fingers approaching from superomedial and retract the abdominal wall if needed. The best solution is however to do the entire nerve block under ultrasound imaging guidance.

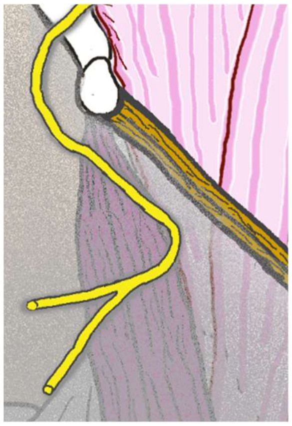
SUMMARY list of the potential Lateral Femoral Cutaneous Nerve variations.

- Nerve root origins can be anything from L1 to L4.
- The nerve can be fully absent. The lateral thigh skin sensation is then supplied by other adjacent sensory nerves.
- The nerve can pass postero-lateral to ASIS, through ASIS or medial to ASIS.
- The nerve can pass above, through or below the inguinal ligament.
- Related to the proximal sartorius muscle, all nerve variants, branches and nerve substitute branches will pass about the proximal sartorius muscle in one of four planes. The four planes are;

1. Immediately <u>deep to sartorius</u>.
2. <u>Within sartorius muscle</u> typically within the mid-muscle fascial line representing the fusion line of the primitive double sartorius muscle seen in quadrupedal animals.
3. <u>Above sartorius muscle but deep to fascia lata.</u>
4. <u>Above sartorius muscle, and superficial to fascia lata,</u> (subcutaneous).

The nerve block target area is the zone all around the proximal sartorius muscle about 3 to 6 centimeters caudad to the sartorius insertion into the ASIS.

Illustrations of the critical LFCN variations



Nerve passing lateral to ASIS and passing over proximal sartorius above fascia lata.

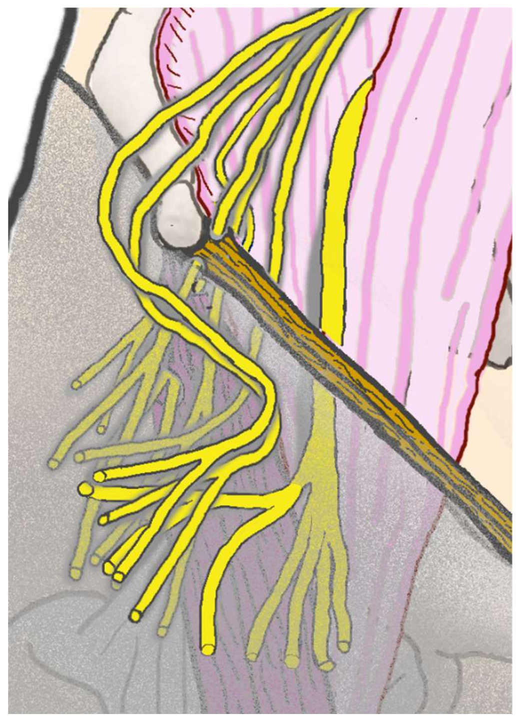
Nerve passing medial to ASIS, and passing over proximal sartorius while under fascia lata. (window created for viewing)

Nerve passing under both inguinal ligament and sartorius. (Fascia lata window created for viewing.)

Nerve passing under inguinal ligament and through sartorius. (Fascia lata window created for viewing.)

Nerve passing through inguinal ligament, and over sartorius and under fascia lata. (fascia lata window created for viewing).

Absent LFCN. Lateral thigh sensation supplied by a branch of anterior femoral cutaneous nerve from the femoral nerve. The lateral nerve lies above fascia lata.



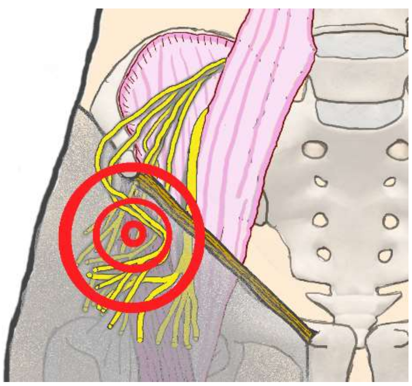
All major variants of LFCN nerve superimposed upon each other in one illustration. (Fascia lata is intact in this illustration.)

5. The technique of blocking the Lateral Femoral cutaneous Nerve.

A. The history of the techniques of blocking the LFCN.

Pauchet published the first book containing a description of blocking the LFCN in 1917[10]. He used needle insertion point 2 cm infero-medial to the Anterior Superior Iliac Spine (ASIS) and injected 4 ml of drug deep to fascia lata and 4 ml of drug superior to fascia lata in a plane parallel to the inguinal ligament. The high percentage of block failures using this technique was soon recognized. Labat[11] translated Pauchet's work in 1922 using an entry point 1.5 cm infero-medial to the ASIS added an extra injection, to improve reliability, placing the needle direct into bone and injected local anesthetic in a series of continuous radial directions of from bone to subcutaneous, for a total of 10 milliliters.

Moore subsequently described a technique inserting the needle 2.5 cm medial and 2.5 cm inferior to the anterior superior iliac spine and vertical to skin[12]. The fascia lata was penetrated with a shallow bevel needle using a "pop" technique to identify the ligament. Moore injected
One milliliter of drug just deep to fascial lata and one milliliter of drug just above fascia lata. He then made four more injections in serial fan-like adjustments. Two are directed in steps towards medial of the first point and the other two towards lateral. Each included injection of just below the fascia lata of 1ml of local anesthetic, and also 1ml more injected just above fascial lata upon needle withdrawal. In addition, Moore added a number of injections. (1) He redirected the needle 45 degrees from the long axis of the body to superior and up to bone and injected 1 ml after withdrawing the needle 1 mm from the bone. (2) He next redirected the needle yet more cephalad and supero-lateral passing under the inguinal ligament and stopping against the bone of ASIS, again injecting 1ml after withdrawing the needle 1 mm. (3) He finally injected 1 ml of drug above fascial lata for branches above fascia lata at the point of needle insertion. A total of 15 ml was required. It seems an inadequate block was always a persistent occurring problem requiring repeat injections.



Target area to inject the LFCN, at four different depths.

TC Brown in 1986 described a 2 "pop" technique inserting the needle immediately medial to ASIS, but no-one has referred to this approach again. The first pop would be the sum of all the anterior abdominal muscles (obliquus externus, obliquus internus and transversus abdominis) attachments to the inner iliac crest, and the second pop would be the iliac fascia on the iliaca muscle against the ilium.

Efforts to improve the technique continued and in DL Brown's book he recommended using a needle entry point 1 cm infero-medial to ASIS. Then 10 ml of local anesthetic was injected in a series of deep to subcutaneous injections randomly radiating in a plane parallel to the inguinal ligament. The book proposed an alternate technique redirecting the needle once into skin, to aim direct to superior at 45 degrees to the skin surface and passing medial to ASIS and under the inguinal ligament. The position was considered good if 2 pops were felt as the needle traversed external oblique aponeurosis and the fascia iliaca. It seems none of these techniques have never been scientifically evaluated for reliability. There are as many variants of these techniques as there are books published on the subject. The failure rates in the pre-ultrasound era were high and ranged from 60% to 26% in reports[13], [18]. This is likely due to the wide variations in anatomy.

In regional anesthesia there is also renewed interest in this nerve block due to growing interest in performing leg surgery entirely under nerve block, and a trend to doing multiple and specific nerve blocks using smaller drug volumes aided by ultrasound guidance all since about 2007.

B. CLASSIFICATION OF Lateral Femoral Cutaneous Nerve block techniques.

B1. Nerve stimulator Guided LFCN blocks[13].

As the LFCN nerve is pure sensory no surrogate muscle twitch can be used with electro-stimulation to locate the nerve. Using sensory electrostimulation has been done and the one small series reported 100% success in 20 volunteers. The drawback of using electrostimulation to elicit sensory responses is that the patient needs to be unsedated in order to verbally report sensations experienced to the physician. Also, higher nerve stimulator currents need to be used than that used for motor stimulation. This is due to sensory nerves having a higher Rheobase than motor nerves. The stimulation is painful and more time consuming than blind speculative injection techniques. There is also no guarantee that every branch is blocked as there is no way of knowing how many branches exist. This method has only achieved limited popularity and is not recommended.

B2. Bulk nerve block techniques, that include the LFCN.

These are techniques based on injecting large drug volumes at a point far away from the nerve with the hope that drug will spread under fascial layers and or within fascial compartments to reach the LFCN and other nerves as well.

i. **Psoas compartment block.**

This block when performed at L3 or L4 vertebral height reliably includes the roots (L2 and L4) of the LFCN. By the nature of being an intramuscular block drug is removed swiftly and compared to specific nerve blocks like a femoral nerve block with nerve stimulator, psoas nerve blocks are slow in onset, modest in density and fast in offset. However, they are most useful when obturator and femoral blocks are needed together with a LFCN block. The psoas block combines best with a GA technique, but awake-surgery can be performed if the sciatic is added for some surgeries and sufficient “soak time” is given to the patient before surgery is allowed to commence. The psoas block is highly recommended block for cases needing nerve blocks of all the leg, excluding the sciatic nerve. If the sciatic nerve needs to be blocked it is an easy second nerve to be blocked separately.

ii. **Winnie three-in-one block.**

Dr. Winnie postulated that a large volume femoral nerve block (e.g. 40 ml) when injected caudad to but close to the inguinal ligament, all of LFCN, femoral and obturator nerve blocks would be obtained. Multiple studies show that all three nerves are seldom blocked in one patient. Also, it is mostly the LFCN component is the most likely component to be missed. This occurs in 33% and more of cases[14]. The Winnie three-in-one technique is not recommended at all for any reason.

iii. **Fascia Iliaca block.**

This is technique once considered attractive because of a perception of being safe, but its reliability in achieving nerve block of both the femoral nerve and the LFCN is so poor that it strongly advised against ever being used.

B3. Lumbar epidural or spinal block.

B4. Blind speculative field blocks using tactile information.
This is a recommended technique when the physician lacks ultrasound equipment or skills in performing ultrasound guided regional anesthesia and LFCN is essential for the patient to have. A detailed illustrated recommended technique used by this author success fully prior to obtaining ultrasound equipment in 2007 follows.

B5. Ultrasound guided nerve visualizing LFCN blocks.
One study was reported in 1995[15]. They were able to identify the nerve medial to ASIS holding a high frequency linear probe parallel to the inguinal ligament and gliding it cephalad or caudad, and also medial or lateral until the nerve was identified immediately caudad to the inguinal ligament. The nerve is hard to identify for both the reason that it is small and flat, and because it may lie so very close to the surface in the typical "grey zone" of poor imaging immediately below the transducer. They had 100% success in 10 patients reviewed retrospectively. They had success with doses from 8ml to 2 ml. This was a retrospective descriptive "feasibility" trial and no evidence was given of abandoned cases or complications. The LFCN is 0.78mm thick and 2.25 mm across and this author cannot consistently identify it in all subjects using ultrasound imaging. When seen the nerve is not obvious and usually a significant time period was spent closely studying the region before the nerve was discovered. This technique is not recommended for use with analgesia nerve blocks.

B6. Ultrasound guided tissue plane targeted block for the LFCN.
This is the most recommend technique. Please see the video demonstration at regional-anesthesia.com, or at vid-RAC on Vimeo. A detailed description follows

C. THE RECOMMENDED NERVE BLOCK TECHNIQUES.

There are two recommended nerve block techniques for the LFCN. The ideal one utilizes ultrasound guidance to visually locate four tissue planes into which local anesthetic drug should be injected. The alternative technique attempts to blindly inject the same four planes, but with some duplication of injection to reduce the risk of any failed portion of the injection.

1) Blind speculative field block for the LFCN.

This technique should only be used in the absence of an available suitable ultrasound machine and the skills and experience of using and ultrasound machine it in performing regional anesthesia.

All variants of LCNT enter the thigh on in one of three manners;

A. <u>Above</u> fascia lata passing posterolateral to ASIS.
B. <u>Below</u> fascia lata after passing medial to ASIS.
C. As accessory branches derived from various other pelvic and inguinal region nerves when the <u>LCNT is absent</u>.

Those three groups of nerves all pass in relation to the most cephalad (proximal) part of the sartorius muscle at some point before they supply sensation to the lateral thigh. The nerves, at this point, pass relative to the sartorius muscle; (i) deep to the muscle, (ii) within the muscle, (iii) superficial to the muscle and under fascia lata, or (iv) superficial to both the muscle and fascia lata (subcutaneous). Drug should be targeted into each of those fascial compartment planes, with some additional duplication of injections to compensate for first injections missing the intended fascial plane, which is inherent in using blind techniques.

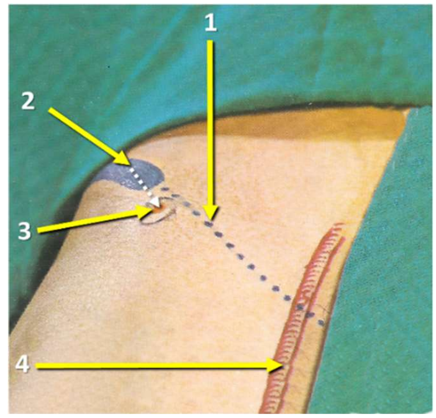


Figure #6. Illustration of the right-side groin region.
1. The inguinal ligament.
2. The anterior superior spine (ASIS).
3. Needle insertion point 2.5 cm infero-medial to ASIS.

1. IDENTIFY the first proximal fleshy part of Sartorius muscle by marking a skin point 2.5 cm infero-medial to ASIS. See figure #6.

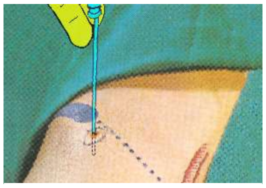


Figure #7.

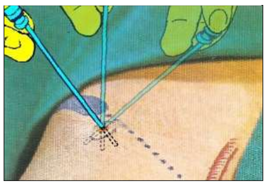


Figure #8.

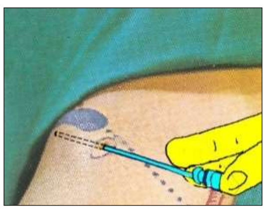


Figure #9.

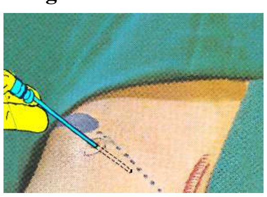


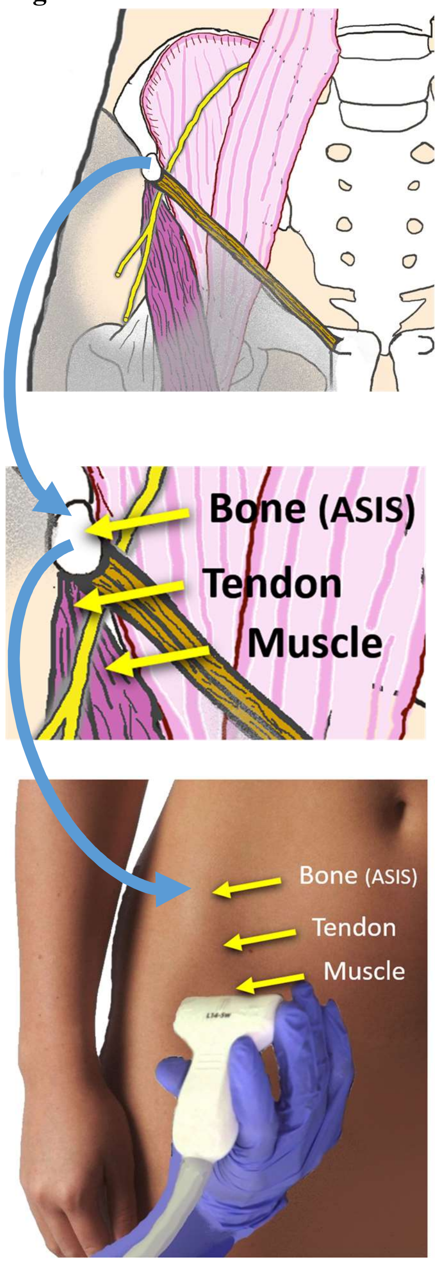
Figure #10.

2. INSERT a blunt tip shallow bevel needle gently through the marked skin point vertical to the skin. A standard fifty-millimeter nerve block needle is perfect. See figure #7. Inject 2 milliliters of local anesthetic solution immediately subcutaneous. Next advance the needle very slowly with a gentle grasp and identify by feel the moment it passes through fascia lata by feeling the tissue “pop”. Inject 2 ml of local anesthetic immediately again assuming this is above the muscle and below fascia lata. Advance the needle again and inject after the third feeling of a “pop” assuming the needle tip is within sartorius muscle. Advance the needle a last time and inject 1 ml after the forth “pop” assuming the needle tip is just deep to sartorius muscle. Repeat these all two more times reinserting the needle aiming slightly more medial once, and slightly more lateral once. Omit the direct subcutaneous injection these times. See figure #8.

3. INJECT A SUBCUTANEOUS TRACT of local anesthetic from the needle insertion point direct towards lateral for about 4 centimeters. Passing caudad to ASIS and inject about 2 ml over a distance of about 4. Next inject a similar tract of subcutaneous using 2 milliliters local anesthetic for 3 cm to medial, away from ASIS, but still caudad to the inguinal ligament. See figure #10. A total of 15 milliliters of local anesthetic is used.

2) Ultrasound guided tissue-plane-targeted block for the LFCN.

Figure #11.



Use a broad linear array transducer, e.g. 40mm broad, and using frequencies within the range of 7 to 12MHz.

Identify the Anterior Superior Iliac Spine (ASIS) and place the transducer on the skin over it.

See figure #11. It shows first the deep anatomy of the proximal sartorius anatomy, then the deep anatomy in close up lastly the superficial anatomy of the region of the proximal sartorius muscle.

The Anterior Superior iliac spine is the key starting structure for this nerve block. It must first be identified by palpation and the verified by ultrasound scanning.

Align the transducer in a transverse axis across the patient. Identify the ASIS in the sonogram. Then slowly glide the transducer towards the feet and slightly towards medial.

Identify the tendon of the sartorius muscle that attaches to ASIS. Stop moving the transducer when the tendon has expanded into a fully flesh sartorius muscle.

Figure #12 is a sketch showing the structures that can be recognized when ultrasound scanning the proximal sartorius muscle.

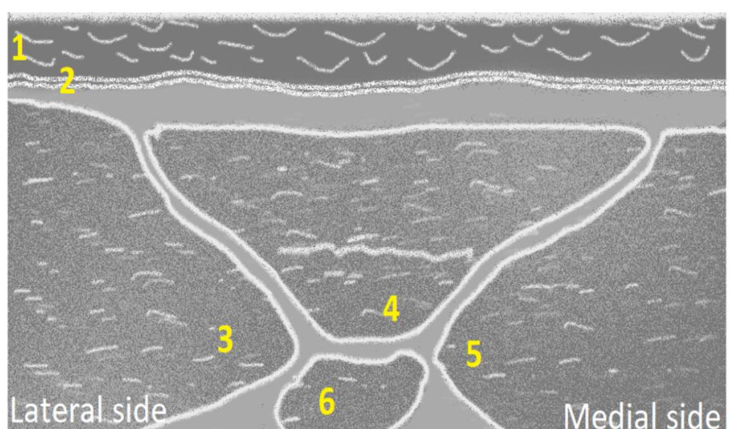


Figure # 12. Proximal sartorius muscle.
1. Subcutaneous fat.
2. Fascial iliaca
3. Tensor fascia lata muscle on the lateral side.
4. Sartorius muscle.
5. Ilio-psoas muscle on the medial side.

The tendon of biceps femoris muscle.

Figure #13. Sonograms of ASIS, the sartorius tendon, and sartorius muscle.

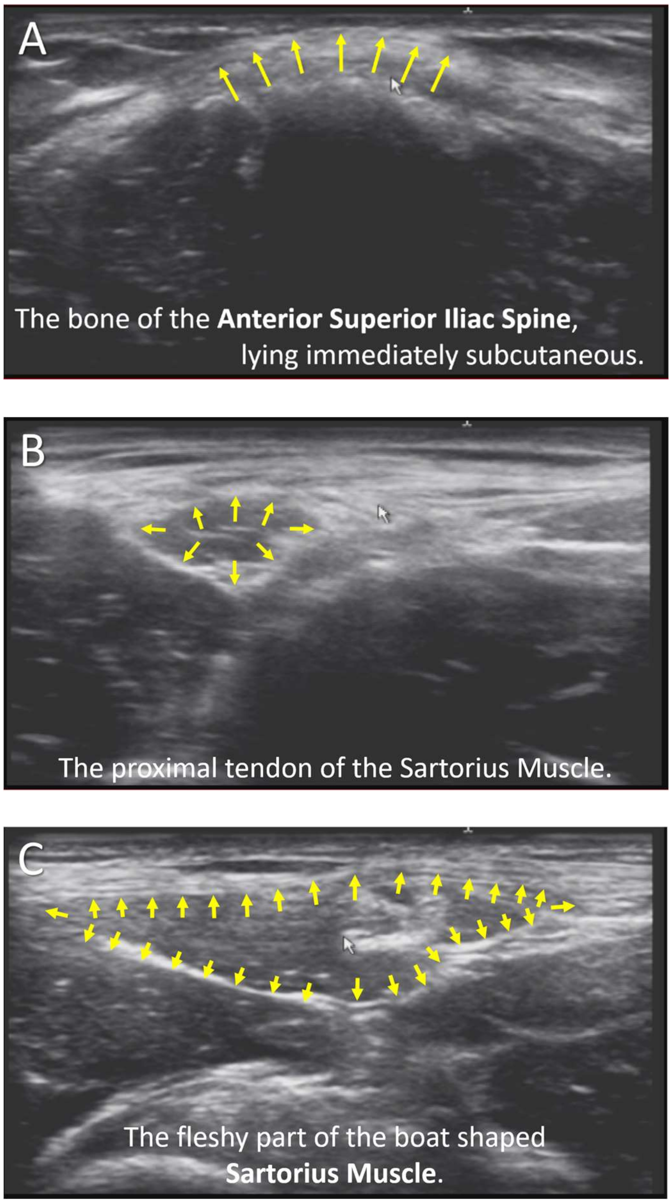
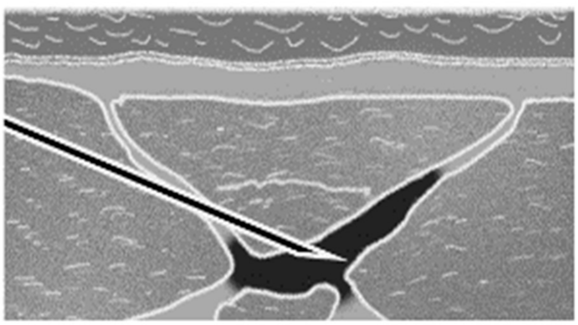


Figure #13 shows three actual sonograms of the ASIS, the sartorius tendon, and the proximal sartorius muscle.

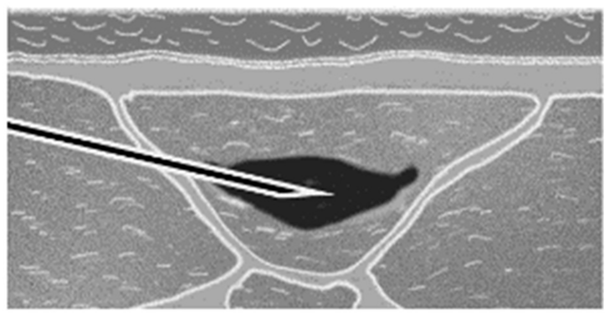
Insert a 90 mm long nerve block needle through the skin to form an in-plane view of the needle in the sonogram. Needle insertion may be from either medial or from lateral. Make four serial injections always starting from deepest and ending subcutaneous. If one starts superficial sometimes bubbles in the injection corrupt the sonogram and this then makes the deeper injections harder to do. See figure #12

Place the needle tip just deep to the center part of the sartorius muscle. Inject 2 ml of local anesthetic drug. Redirect the needle to the center of sartorius muscle. Inject 2 milliliter of drug. Reposition the needle just above the sartorius, and deep to the fascia iliac. Inject the major dose of the LFCN block, being 9 milliliters of drug. Last redirect the needle to just below the skin and inject 2 ml of drug above fascia lata.

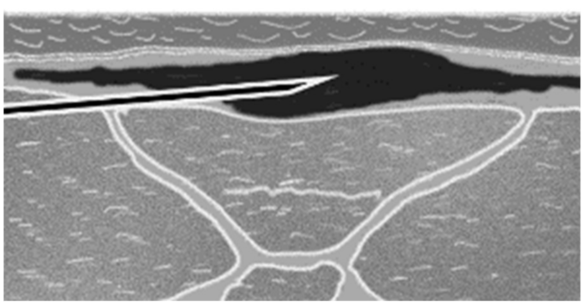
Clinical experience and review of the scientific information on the anatomic variations of the LFCN support that this rationalized technique of distributing the volume of local anesthetic will be successful in nerve blocking all anatomy variants of the LFCN.



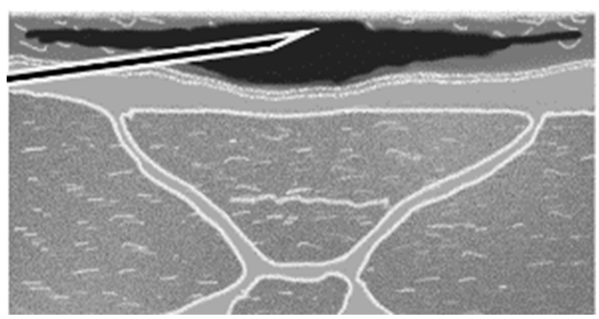
Inject 2 ml below sartorius.



Inject 2 ml within sartorius.



Inject 9 ml subcutaneous above fascia lata.



Inject 2 ml subcutaneous above fascia lata.

CHOICE OF LOCAL ANESTHETIC

Any local anesthetic can be used as is appropriate for the intended use of the block, the desired duration of the block and considering the total of drug needed for other nerve blocks and concern for local anesthetic toxicity. Examples, for short duration diagnostic blocks where fast information is needed, 1% to 2% lidocaine (lignocaine) can be used. For longer duration analgesia blocks 0.25% to 0.5% bupivacaine can be used as well as 0.5% to 0.75% ropivacaine. The addition of epinephrine (adrenaline) to extend block duration and slow drug absorption, is reasonable A total volume of 10 ml to 15 ml is recommended.

In order to minimize the total drug amounts administered to the patient one must consider whether the LFCN block's use is primarily for patient relief of tourniquet discomfort or the surgical skin incision. A moderately intense nerve block will be sufficient to aid the patient feeling comfortable during tourniquet insufflation. A fully developed intense nerve block is however needed to allow an awake patient tolerate skin incisions and use of electrocautery in the subcutaneous tissue. For relieving tourniquet discomfort comfort the LFCN block should be done last using 0.375% or better, 0.5% Ropivacaine. However, for relief of the discomfort from surgical incisions and use of electrocautery nothing less than 0.75% ropivacaine should be used.

Also, if the LFCN block is being done for awake surgery and for comfort of surgical incision it should be injected <u>first</u> of all the nerves using 0.75% ropivacaine. This will give the LFCN the longest soaking time bathed in local anesthetic drug ensuring the LFCN block is well established by the time of the first incision.

INDICATIONS FOR Lateral Femoral Cutaneous Nerve block.

The LFCN can be blocked for any surgery involving skin incisions in the lateral thigh, or application of an upper leg tourniquet in awake patients.

Examples of uses;

1. <u>Split skin graft harvest on the outer thigh</u>. For awake skin harvesting, mark the precise area of anesthesia with ice sensation testing before surgery. The surgeon should confine skin harvesting to this marked area. Often the graft site washing and skin application can be tolerated by the patient if skillfully administered sedatives and analgesics, and if the surgeon appropriate modifies their technique. This is usually feasible if the major skin recipient area has already been debrided on an earlier day. Using Bupivacaine 0.5% with epinephrine (adrenaline added typically gives about 18 to 24 hours skin harvest area analgesia. This is a good indication for LFCN block.
2. <u>Quadriceps muscle biopsies from vastus lateralis.</u> The LFCN block will provide anesthesia to the overlying skin but not the muscle. It is important to demarcate the area of anaesthesia before making an incision. If the muscle cutting surgery is sufficiently gentle, sufficiently small (incision not exceeding 1 cm), no electrocautery is used, and the patient is stoic and motivated to endure modest discomfort to avoid general anesthesia then deep sedation with opiates may be sufficient for the muscle cutting portion of the surgery. Otherwise general anesthesia is needed or a deep muscle field block (which can contaminate the sample). Blocking the LFCN alone is generally <u>not a good use</u> for the taking of a vastus lateralis muscle biopsy in awake patients.
3. <u>Anesthetize the skin for the incision for total hip arthroplasty.</u> If the decision is taken to avoid general anesthesia and neuraxial anesthesia an independent LFCN block is an essential component of the multiple required nerves to be blocked to make awake surgery feasible. The patient will need mild sedation and mild analgesia to tolerate the physical discomfort of positioning on the table and the physical distractions of surgical bone cutting and hammering. Whilst hip arthroplasty under peripheral nerve block is feasible it is rarely done. The requirements for success would be having an excellent surgeon motivated to be time efficient as well as patient with the patient and the anesthesiologist. The anesthesiologist would have

to be superbly skilled and experienced with regional anesthesia to confidently deliver effective blocks of tissue in the distribution of the full hip joint, the buttock muscles and skin the groin up to the inguinal ligament. The effectively blocked nerves would have to include the following nerves; obturator, femoral, parasacral sciatic, subcostal, ilioinguinal, and LFCN. A large number of those nerves would be best blocked via psoas compartment block. The pain after surgery deriving from the bone, and joint capsule incisions vastly exceeds in magnitude any pain derived from skin incisions. Thus, a separate isolated LFCN block is very rarely used with hip surgery even if only intended to contribute to post-surgical analgesia after surgery under general or neuraxial anesthesia.

4. Provide comfort for thigh tourniquet usage during awake distal femur, knee or lower leg awake surgery. Other peripheral nerve blocks are need for all the tissue incisions. Morin investigated LCNT blocks for relief of thigh tourniquets discomfort in 40 patients under awake knee arthroscopy under direct knee infiltration of local anesthetics[16]. All patients got a sciatic nerve block. They were then randomized to receive either an additional femoral nerve block or a LFCN block. In the LFCN block group 65%, and 35% of the femoral nerve block group experienced tourniquet pain upon tourniquet insufflation. Clearly each group had large portions of feeling tissues under the tourniquet, all be it different tissues in each case. This author uses a combination of obturator nerve, femoral nerve, sciatic nerve, and LFCN block for awake surgery of the distal femur, knee and lower leg with all patients experiencing zero pain during awake unsedated surgery. Whilst this is not the preferred anesthesia technique in routine young healthy patients, it is the author's preferred anesthesia technique for aged critically ill patients on anticoagulation therapy.

    CASE example. An 85-year-old lady with recent heart failure, severe ischemic heart disease, peripheral vascular disease, low molecular weight heparin therapy for recently placed coronary arterial stents, needed an urgent above knee amputation for gangrene of the lower leg. It was desirable to avoid general anesthesia, and critical to avoid neuraxial anesthesia. The amputation was done with a transgluteal parasacral sciatic nerve block, femoral nerve block, obturator block and LCNT block with as little as 35 ml of drug[17]. Minimum sedation was used.

5. For treatment of meralgia paresthetica. Many of the variant nerve courses of the LFCN, for example passing though the inguinal ligament, make the nerve vulnerable to experience entrapment neuropathies, hence meralgia paresthetica is common. In patients suffering from that, LFCN blocks have diagnostic and therapeutic benefits.

COMPLICATIONS and SIDE-EFFECTS of the LCNT block.

In general, the LFCN block is a very safe block. Complications are defined as uncommon, unpredictable, and unwanted effects which are sometime very serious. Side effects are defined as relatively common, predictable and unwanted effects which have no long-term major consequences. Various procedural strategies can eliminate the incidence of some, or reduce the incidence of others in varying degrees. Sometimes some side effects are entirely unavoidable and inherent to the procedure, and are simply part of the risk-benefit considerations of clinical decision making.

LFCN potential problems are;

1. **Failure**. This is between 30 and 60% using the blind fan injection techniques[18]. It is zero using ultrasound sartorius muscle targeted technique, in this author's experience.
2. **Unwanted femoral nerve block**. Using 7 – 10 ml of local anesthetic, in one blindly widely injected technique, this occurred in 5% of cases[19]. About half the femoral block were complete and half were partial but still disabling. Using 15 ml this occurs in about 30% of cases in this study. This author has not observed this using the ultrasound guided sartorius target technique.

3. **Other**; Typical of any invasive procedure, there can be discomfort during awake nerve block injection. Local anesthetic toxicity can occur if the total amount of drug used combined with the other nerve blocks is excessive. Injection site infection can theoretically occur.

CONCLUSION;

This author has used the LFCN block, combined with other nerve blocks, successfully in numerous awake surgeries like below-knee amputations and above-knee amputations in severely ill aged patients. The other additional nerves blocked are usually the femoral, sciatic, and obturator nerves. In above-knee amputation in sickly aged patients there is often concomitant anticoagulant therapy or cardiac disease, like severe aortic stenosis, that absolutely contraindicates neuraxial anesthesia, but only relatively contra-indicates peripheral nerve blocks. Usually then the risk-benefit considerations strongly support performing the peripheral nerve blocks. Even if the nerve blocks are combined with general anesthesia to ensure ventilatory adequacy, the nerve blocks facilitate light anesthesia, fast awakening from anesthesia, and allow total avoidance of postoperative opiates for a substantial period.

If the LFCN block is needed together with a femoral and or obturator nerve block (e.g. for hip joint surgery) and a primary anesthetic is going to be general anesthesia, then the LFCN would be best blocked as part of a psoas compartment block at lumbar plexus root level. The psoas compartment also has the advantage of being easily catheterized to facilitate maintaining the analgesia for a few days after surgery.

It is also this author's anecdotal experience that using the above recommended ultrasound guided technique the success rate of the LFCN block based on generally observed postoperative pain scores and successful wake surgeries is 100%. Ideally a large prospective study using this chapter's four injection ultrasound guided tissue-plane-targeted block for the LFCN should be done to validate this tentative experience. Considering the incidence of anatomic variations such a study would need an estimated 500 or 600 cases. After performing the block, the area of lateral thigh sensation loss should be documented before any other nerve blocks are done. The next option to scientifically validate the merits of four injection ultrasound guided tissue-plane-targeted block for the LFCN would be for many users to report in letter form their personal success, or lack thereof. Accumulated letter reports of experience would be useful to the professional anesthesiology community.

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