Sensory nerve conduction studies

Department of clinical neurophysiology
University hospital
Uppsala, Sweden

1997-12-16

Björn Falck, Erik Stålberg and Lena Eriksson

Department of clinical neurophysiology
University hospital
Uppsala, Sweden
In the following section a detailed description of the methods for sensory nerves studied in the department.

Surface electrodes.
The surface electrodes used both for stimulation and consist of two felt pads with a diameter of 7 mm. The electrodes are fixed on a plastic bar. The distance between the electrodes is 23 mm. These electrodes are available from Medtronic (Medtronic 9013L0361) and Nihon Kohden xx.

Near nerve electrodes
The electrodes used for recording in the department are Medtronic 9013L0601 (25mm), 9013L0611 (35mm), 9013L0621 (45mm) and 9013L0631 (60mm). The length of the recording electrodes depends on the amount of subcutaneous tissue. The identical electrodes can be used for stimulation, but thinner electrodes are used (Medtronic 9013L0641).

N. AURICULARIS POSTERIOR
Type of measurement: Antidromic.
Position of head: Slightly rotated to the contralateral side of the measured nerve.
Type of recording electrodes: Plate electrodes.
Placement of recording electrodes: Behind the earlobe.
Type of stimulating electrodes: Surface electrodes on a fixed bar.
Stimulation sites: On the posterior border of m.sternocleidomastoideus in the middle of the muscle.

N. RADIALIS
Type of measurement: Antidromic.
Position of limb: Subject supine, elbow extended, and forearm midway between pronation and supination.
Type of recording electrodes: Surface electrodes on a fixed bar.
Placement of recording electrodes: Active electrode over the middle of I metacarpal bone overlying the tendon of the extensor pollicis muscles. Reference electrode placed distally.
Type of stimulating electrodes: Surface electrodes on a fixed bar.
Stimulation sites:

- Lateral side of the forearm 140 mm proximal to the recording electrode.
- Elbow, medial to m.brachioradialis and lateral to the biceps tendon
- Upper arm in the radial groove

Picture of SCS n Radialis

**N. MEDIANUS**

Type of measurement: Orthodromic.

Position of limb: Subject supine, elbow extended, and forearm supinated.

Type of recording electrodes: Surface electrodes on a fixed bar.

Placement of recording electrodes: Above the wrist around 140mm proximal to the stimulating electrode, usually at the site where n.medianus is stimulated at for motor nerve conduction studies. Reference electrode placed proximaly.

Type of stimulating electrodes: Surface electrodes on a fixed bar.

Stimulation sites:

- Base of digit I
- Base of digit II
- Base of digit III
- Base of digit IV
- Palm

Picture of orthodromic SCS n Medianus

**N. MEDIANUS**

Type of measurement: Antidromic.

Position of limb: Subject supine, elbow extended, and forearm supinated.

Type of recording electrodes: Surface electrodes on a fixed bar.

Placement of recording electrodes: The active electrode is placed on palmar surface of the digit over the middle of the proximal phalanx of digits I-IV. Reference electrode placed distally.

Type of stimulating electrodes: Surface electrodes on a fixed bar.
Stimulation sites:
- Palm, around 70 mm (50-80 mm) proximal to the recording electrode
- Wrist 140 mm proximal to the recording electrode in digits II, III and IV. The distance is 100-120 mm for digit I.
- Elbow, immediately medial to the tendon of the biceps.

N. ULNARIS

Type of measurement: Orthodromic.
Position of limb: Subject supine, elbow extended. Forearm supinated.
Type of recording electrodes: Surface electrodes on a fixed bar.
Placement of recording electrodes: Above the wrist around 140mm proximal to the stimulating electrode, usually at the site where n.ulnaris is stimulated at for motor nerve conduction studies

Stimulation sites:
- Base of digit IV
- Base of digit V
- Palm

Picture of orthodromic SCS n Ulnaris

N. ULNARIS

Type of measurement: Antidromic.
Position of limb: Subject supine, elbow in 15-30 degree flexion if the segment across the elbow is measured, otherwise extended. Forearm supinated.
Type of recording electrodes: Surface electrodes on a fixed bar.
Placement of recording electrodes: The active electrode is placed on palmar surface of the digit over the middle of the proximal phalanx of digits IV or V. Reference electrode placed distally.
Type of stimulating electrodes: Surface electrodes on a fixed bar.
Stimulation points:
- Palm, around 70 mm proximal to the recording electrode
- Wrist 140 mm proximal to the recording electrode.
- Below elbow, cathode about 10-20 mm distal to the medial epicondylus
- Above elbow, cathode about 75-95 mm above the medial epicondylus.

**N. Ulnaris Ramus Dorsalis**

*Type of measurement:* Antidromic.

*Position of limb:* Subject supine, elbow extended, and forearm pronated.

*Type of recording electrodes:* Surface electrodes on a fixed bar.

*Placement of recording electrodes:* Active electrode between metacarpal bones IV and V in the middle of the metacarpal bones. Reference electrode placed distally.

*Type of stimulating electrode:* Surface electrodes on a fixed bar.

*Stimulation site:* Distal part of forearm, 80-120 mm proximal to the recording electrode.

*[Picture of SCS n Ulnaris Ramus Dorsalis]*

**N. Cutaneus Antebrachii Lateralis**

*Type of measurement:* Antidromic.

*Position of limb:* Subject supine, elbow extended, and forearm supinated.

*Type of recording electrodes:* Surface electrodes on a fixed bar.

*Placement of recording electrodes:* Active electrode over the anterior-radial side of the forearm between the distal and middle third of the forearm, 140 mm distal to the tendon of m. biceps brachii. Reference electrode placed distally.

*Type of stimulating electrodes:* Surface electrodes on a fixed bar.

*Stimulation point:* Elbow, lateral to the tendon of the biceps muscle.

*[Picture of SCS n Cutaneus Antebrachii Lateralis]*

**N. Cutaneus Antebrachii Medialis**

*Type of measurement:* Antidromic.

*Position of limb:* Subject supine, elbow extended, and forearm supinated.

*Type of recording electrodes:* Surface electrodes on a fixed bar.

*Placement of recording electrodes:* Active electrode over the anterior-ulnar side of the forearm at between the distal and middle third of the forearm (140 mm). Reference electrode placed distally.
Type of stimulating electrodes: Surface electrodes on a fixed bar.

Stimulation site: Over the volar side of the forearm, 20-30 mm in anterior and lateral to the medial epicondyle.

Picture of SCS n Cutaneus antebrachii medialis

**N. CUTANEUS ANTEBRACHII POSTERIOR**

Type of measurement: Antidromic.

Position of limb: Subject supine, elbow extended, and forearm pronated.

Type of recording electrodes: Surface electrodes on a fixed bar.

Placement of recording electrodes: Active electrode over the central part of the dorsal side of the forearm 140 mm distal to the lateral epicondyle. Reference electrode placed distally.

Type of stimulating electrodes: Surface electrodes on a fixed bar.

Stimulation site: Slightly medial to lateral epicondyle.

Picture of SCS n Cutaneus antebrachii posterior

**N. SURALIS**

Type of measurement: Antidromic.

Position of limb: Subject prone. Knee extended, ankle in a neutral position.

Type of recording electrodes: Surface electrodes on a fixed bar.

Placement of recording electrodes: Active electrode behind the lateral malleolus. Reference electrode placed distally.

Type of stimulating electrodes: Surface electrodes on a fixed bar.

Stimulation sites:

- On the dorsal aspect of the calf, 140 mm proximal to the recording electrode.
- Behind the knee.

Picture of SCS n Suralis

**N. PERONEUS PROFUNDUS**

Type of measurement: Orthodromic.
Position of limb: Subject supine, knee extended. Ankle in neutral position.

Type of recording electrodes: Surface electrodes on a fixed bar.

Placement of recording electrodes: Active electrode placed over n.peroneus profundus at the site used for distal stimulation of the motor nerve conduction velocity. The exact location may vary slightly from one subject to another. Usually 1-2 cm lateral to the m.tibialis anterior tendon.

Type of stimulating electrodes: Surface electrodes on a fixed bar.

Stimulation site: Stimulating cathode in the interspace between the I and II metatarsal bones just proximal to the MCP joint.

Picture of SCS n Peroneus profundus

N. PERONEUS SUPERFICIALIS RAMUS MEDIALIS (n.cutaneus medialis dorsalis)

Type of measurement: Antidromic.

Position of limb: Subject supine, knee extended. Ankle in neutral position.

Type of recording electrodes: Surface electrodes on a fixed bar.

Placement of recording electrodes: Active electrode placed over the middle of the first metatarsal bone. Reference electrode placed distally.

Type of stimulating electrodes: Surface electrodes on a fixed bar.

Stimulation site: Stimulating cathode 140 mm proximal to the recording electrode on the lateral side of the leg.

Picture of SCS n Peroneus superficialis ramus medialis

N. PERONEUS SUPERFICIALIS RAMUS LATERALIS (n.cutaneus intermedius dorsalis)

Type of measurement: Antidromic.

Position of limb: Subject supine. Knee extended and ankle in a neutral position.

Type of recording electrodes: Surface electrodes on a fixed bar.

Placement of recording electrodes: The active electrode is placed over the middle of the third metatarsal bone. Often the nerve can be seen when the ankle is slightly inverted. Reference electrode placed distally.

Type of stimulating electrodes: Surface electrodes on a fixed bar.

Stimulation site: Stimulating cathode 140 mm proximal to the recording electrode on the lateral side of the leg.

Picture os SCS n Peroneus ramus lateralis
N. SAPHENUS

Type of measurement: Antidromic.

Position of limb: Subject supine, knee extended.

Type of recording electrodes: Surface electrodes on a fixed bar.

Placement of recording electrodes: Over the anterior-medial surface of the distal part of the tibia, 150 mm above the medial malleolus. Reference electrode placed distally.

Type of stimulating electrodes: Surface electrodes on a fixed bar.

Stimulation sites:
- Over the medial side of the tibia 140 mm proximal to the recording electrode.
- (On the medial side of the knee just below the medial epicondyle.)

Picture of SCS n Saphenus

N. CUTANEUS FEMORIS LATERALIS

Type of measurement: Antidromic.

Position of limb: Subject supine, hip extended.

Type of recording electrodes: Surface electrodes on a fixed bar. Electrode has to be attached with adhesive tape.

Placement of recording electrodes: 140 mm distal to spina iliaca anterior superior over the thigh. Reference electrode placed distally.

Type of stimulating electrodes: Surface electrodes on a fixed bar.

Stimulation site: Just proximal to the spina iliaca anterior superior.

Note: With this method it is not possible to measure the conduction velocity across the entrapment site in "meralgia paresthetica". Orthodromic measurement with near nerve electrodes is recommendable in most patients.

N. CUTANEUS FEMORIS LATERALIS

Type of measurement: Orthodromic.

Position of patient: Patient supine.

Type of recording electrodes: Near nerve needle electrodes.
Placement of recording electrode: 5-10 mm above spina iliaca anterior superior. Depth of electrode placement depends on the amount of subcutaneous fat. In lean persons the depth is around 10-15 mm and in obese persons it may be 30-40 mm (when you place the electrode deeper than 15 mm try to direct it slightly lateral to avoid penetration of the peritoneum). Often it is possible to place the recording electrode blindly and find a good recording site. Sometimes it is helpful to stimulate with the recording electrode to ascertain that the electrode is close to the nerve. If the patient has a paresthetic sensation in radiating into the lateral side of the thigh with a stimulus intensity of 1-2 mA (0.2 ms duration) the electrode is very close to the nerve. Often it is difficult to obtain this and acceptable responses may be recorded with 3-5 mA stimulus thresholds for the sensation.

Placement of reference electrode: Subcutaneously 20-30 mm proximal to the recording electrode. A surface reference electrode may be used instead of a needle.

Type of stimulating electrodes: Surface electrodes on a fixed bar.

Stimulation site: Over the anterior-lateral portion of the thigh around 100-140 mm distal to the recording electrode. Often it is necessary to search for the site.

Picture of SCS n Cutaneus femoris lateralis

N. CUTANEUS FEMORIS POSTERIOR

Type of measurement: Antidromic.

Position of limb: Subject prone.

Type of recording electrodes: Surface electrodes on a fixed bar.

Placement of recording electrodes: Active electrode over the middle of the posterior side of the thigh. Reference electrode placed distally.

Type of stimulating electrodes: Surface electrodes on a fixed bar.

Stimulation site: Just below the buttock 140 mm proximal to the recording electrode.

Picture of SCS n Cutaneus femoris posterior

N. PLANTARIS MEDIALIS

Type of measurement: Orthodromic.

Position of limb: Subject supine, knee extended, and ankle in a neutral position.

Type of recording electrodes: Surface electrodes on a fixed bar.

Placement of recording electrodes: Active electrode above the medial malleolus. Reference electrode placed proximally.
Type of stimulating electrodes: Surface electrodes on a fixed bar.

Stimulation point: On the medial side of the sole of the foot, the cathode 100-140 mm from the recording electrode.

Picture of SCS n Plantaris medialis/ lateralis

N PLANTARIS MEDIALIS

Type of measurement: Orthodromic.

Position of patient: Patient supine or sitting.

Type of recording electrodes: Near nerve needle electrodes.

Placement of recording electrode: 10-20 mm above the medial malleolus. To place the electrode close to the tibial nerve the recording electrode is used to stimulate and the motor response is picked up from m.abductor hallucis with surface electrodes. When the threshold for a motor response is around 1mA (stimulus duration 0.2 ms) the position of the recording electrode is acceptable. Thresholds of more than 3 mA rarely give satisfactory recording.

Placement of reference electrode: Subcutaneously 20-30 mm proximal to the recording electrode. A surface reference electrode may be used instead of a needle.

Type of stimulating electrodes: Surface electrodes.

Stimulation site: On the medial side of the sole (over the I or II metatarsal bone) of the foot 100-140 mm distal to the recording electrode

N. PLANTARIS LATERALIS

Type of measurement: Orthodromic.

Position of limb: Subject supine, elbow extended, and forearm midway between pronation and supination.

Type of recording electrodes: Surface electrodes on a fixed bar.

Placement of recording electrodes: Active electrode above the medial malleolus. Reference electrode placed proximally.

Type of stimulating electrodes: Surface electrodes on a fixed bar.

Stimulation site: On the lateral side of the sole, the cathode 100-140 mm from the recording electrode.

Picture of SCS n Plantaris lateralis/ medialis
N PLANTARIS LATERALIS

Type of measurement: Orthodromic
Position of patient: Patient supine or sitting
Type of recording electrodes: Near nerve needle electrodes.
Placement of recording electrode: 20 mm above the medial malleolus. To place the electrode close to the tibial nerve the recording electrode is used to stimulate and the motor response is picked up from m.abductor digiti minimi with surface electrodes. When the threshold for a motor response is around 1mA (stimulus duration 0.2 ms) the position of the recording electrode is acceptable. Thresholds of more than 3 mA rarely give satisfactory recording.
Placement of reference electrode: Subcutaneously 20-30 mm proximal to the recording electrode. A surface reference electrode may be used instead of a needle.
Type of stimulating electrodes: Surface electrodes on a fixed bar.
Stimulation site: On the lateral side (over the IV metatarsal bone) of the sole of the foot 100-140 mm distal to the recording electrode.

Picture of SCS Plantaris lateralis

N.ILIOINGUINALIS

This is not a standard method that is commonly used.
Type of measurement: Orthodromic.
Position of patient: Patient supine.
Type of recording electrodes: Near nerve needle electrodes.
Placement of recording electrode: 5 -10 mm above spina ilica anterior superior. Depth of electrode placement depends on the amount of subcutaneous fat. In lean persons the depth is around 10-15 mm and in obese persons it may be 30-40 mm (when you place the electrode deeper than 15 mm try to direct it slightly lateral to avoid penetration of the peritoneum).
Placement of reference electrode: Subcutaneously 20-30 mm proximal to the recording electrode. A surface reference electrode may be used instead of a needle.
Type of stimulating electrodes: Surface electrodes on a fixed bar.
Stimulation site: Over the inguinal ligament 80-120 mm from the medial to the recording electrode.

N DIGITALIS I-V PLANTARIS MEDIALIS

Type of measurement: Orthodromic.
Position of patient: Patient supine or sitting.
Type of recording electrodes: Near nerve needle electrodes.

Placement of recording electrode: 10-20 mm above the medial malleolus. To place the electrode close to the tibial nerve the recording electrode is used to stimulate and the motor response is picked up from m.abductor hallucis with surface electrodes. When the threshold for a motor response is around 1mA (stimulus duration 0.2 ms) the position of the recording electrode is excellent. Thresholds of more than 3 mA rarely give satisfactory recordings.

Placement of reference electrode: Subcutaneously 20-30 mm proximal to the recording electrode. A surface reference electrode may be used instead of a needle.

Type of stimulating electrodes: Near nerve needle electrodes.

Stimulation site: The cathode is placed on the medial side close to the base of the toe. Each toe, I-V, is studied separately. The cathode is inserted through the skin from the dorsal side around midway of the toe. The needle is advanced until the tip of the electrode can be felt just under the skin on the plantar side of the toe. The anode is placed distal to the cathode on the same side of the toe.

Stimulus intensity: Optimal stimulus intensity is 3-4 mA (duration 0.2 ms). With high stimulus intensities, > 6-10 mA there is the possibility that the plantar digital nerve on the lateral side of the toe is stimulated.

Averaging: Averaging is required in most subjects. In a young person, less than 30 years of age the responses can usually be seen in the unaveraged trace. Mostly 100-300 stimuli need to be averaged for satisfactory recordings. Sometimes 1000 stimuli are required in older subjects.

Picture of SCS n digitalis I-V Plantaris medialis

N DIGITALIS I-IV PLANTARIS LATERALIS

Type of measurement: Orthodromic.

Position of patient: Patient supine or sitting.

Type of recording electrodes: Near nerve needle electrodes.

Placement of recording electrode: 10-20 mm above the medial malleolus. To place the electrode close to the tibial nerve the recording electrode is used to stimulate and the motor response is picked up from m.abductor hallucis with surface electrodes. When the threshold for a motor response is around 1mA (stimulus duration 0.2 ms) the position of the recording electrode is excellent. Thresholds of more than 3 mA rarely give satisfactory recording.

Placement of reference electrode: Subcutaneously 20-30 mm proximal to the recording electrode. A surface reference electrode may be used instead of a needle.

Type of stimulating electrodes: Near nerve needle electrodes.

Stimulation site: The cathode is placed on the lateral side close to the base of the toe. Each toe I-V is studied separately. The cathode is inserted through the skin from the dorsal side around midway of the toe.
The needle is advanced until the tip of the electrode can be felt just under the skin on the plantar side of the toe. The anode is placed distal to the cathode on the same side of the toe.

**Stimulus intensity:** Optimal stimulus intensity is 3-4 mA (duration 0.2 ms). With high stimulus intensities, > 6-10 mA there is the possibility that the plantar digital nerve on the medial side of the toe is stimulated.

**Note:** Averaging is required in most subjects. In a young person, less than 30 years of age the responses can usually be seen in the unaveraged trace. Mostly 100-300 stimuli need to be averaged for satisfactory recordings.

Sometimes 1000 stimuli are required in older subjects.

SCS n Radialis
SCS n Medianus (orthodromic)
SCS n Ulnaris (orthodromic)
SCS Ulnaris ramus dorsalis
SCS n cutaneus Antebrachii lateralis

SCS n cutaneus Antebrachii medialis
SCS n cutaneus Antebrachii posterior

SCS n Suralis
SCS n Peroneus profundus

SCS n Peroneus superficialis ramus medialis
SCS n Peroneus superficialis ramus lateralis

SCS n Saphenus
SCS n cutaneus Femoris lateralis
SCS n cutaneus Femoris posterior
SCS n Plantaris medialis/lateralis
SCS n Plantaris lateralis (nerve-nerve)
SCS n digitalis I-V plantaris medialis