



## **Somatosensory Evoked Potential (SSEP) Recording Guideline**

1. Purpose of the Guideline
2. Introduction to the Guideline
3. Limits of the Guideline
4. Electrodes
  - (i) Recording Electrode placement
    - a) Upper Limbs
    - b) Lower Limbs
    - c) Lateral and Medial Cutaneous Nerve of the Thigh
    - d) Trigeminal Nerve
  - (ii) Electrode Choice
  - (iii) Electrode Impedance
5. Machine Parameters
  - (i) Common Mode Rejection Ratio
  - (ii) Input Impedance of Pre-amplifiers
  - (iii) Analogue to Digital Signal Conversion
  - (iv) Automatic Artefact Rejection
  - (v) Filter Settings
  - (vi) Sweep Duration
  - (vii) Averaging
6. Recording
  - (i) Patient Information
  - (ii) Patient Attention
  - (iii) Stimulation Site
  - (iv) Stimulation Type
  - (v) Stimulation Rate
  - (vi) Stimulation Duration
  - (vii) Stimulation Intensity
  - (viii) Upper Limb Nerve Stimulation
    - a) Montage
    - b) Markers
  - (ix) Lower Limb Nerve Stimulation
    - a) Montage
    - b) Markers
7. Quality Control
  - (i) Normative Data

## 8. References

Additional Readings

Appendix 1 – Stakeholders

Appendix 2 – Lateral and Medial Thigh SSEP

Appendix 3 – Trigeminal Nerve SSEP

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## 1. PURPOSE

These guidelines have been prepared to offer guidance towards best practice for recording an SSEP in the routine clinical setting within Australia.

## 2. INTRODUCTION

The following guidelines should be considered as minimum standards to record a routine SSEP in clinical practice. They have been prepared by a subcommittee governed by ANTA Inc. and have been presented to stakeholders within the field of Clinical Neurophysiology in Australia (see Appendix 1). A review of international guidelines was made to ensure that this ANTA Inc guideline is consistent with worldwide standards (see reference section).

## 3. LIMITS OF THE GUIDELINE

This guideline relates to the routine SSEP in clinical practice for adults and children only. It does not relate to full term babies and neonates. This guideline does not relate to recording in the operating theatre or non routine setting.

## 4. ELECTRODES

### (i) Recording Electrode Placement

Electrodes should be placed in accordance with the International Federation of Clinical Neurophysiology (IFCN)<sup>(1)</sup> which is the internationally recognised standard.

For the performance of routine somatosensory evoked potentials scalp electrodes should be placed in accordance to the 10/20 Electrode System of the International Federation (10/20ESIF)<sup>(2,3)</sup>.

### a) Upper Limbs

Recording electrodes for upper limb studies should be placed at Erb's Point, C2 and the scalp<sup>(4)</sup>.

- The Erb's Point electrode is placed in the supraclavicular fossa 2cm above the midpoint of the clavicle<sup>(1, 4)</sup>.
- The C2 electrode is placed in the midline at the level of the 2<sup>nd</sup> cervical vertebra<sup>(4)</sup>.
- Additional recording electrodes can be placed at C5 and or C7, at the level of the 5<sup>th</sup> and 7<sup>th</sup> cervical vertebra respectively, if available recording channels allow<sup>(4, 1)</sup>.
- The scalp electrodes are placed 2cm behind C4 (designated C4') and C3 (designated C3') or alternatively midway between C4 and P4 (CP4), midway between C3 and P3 (CP3) together with Fz in accordance with placements from the 10/20 ESIF<sup>(1,2,3)</sup>
- A ground electrode is placed between the stimulating point and the 1<sup>st</sup> recording point at Erb's Point<sup>(1)</sup>.

b) Lower Limbs

Recording electrodes for lower limbs should be placed at the popliteal fossa (PF), the lumbar region (L1-L3) and the scalp <sup>(1)</sup>.

- PF is placed in the popliteal fossa crease<sup>(4)</sup> over the pathway of the stimulated nerve. A reference electrode (PF') is placed 5cm cephalad to (above) the PF <sup>(4)</sup> or on the medial surface of the knee, over the medial femoral condyle <sup>(1)</sup>
- Lumbar recording (L1-3) electrode is placed over the spinous process of any of L1, L2 or L3 <sup>(1,4)</sup>. The reference electrode is placed either 2 or 3 interspaces away <sup>(4)</sup> or on the Iliac Crest (IC) <sup>(1,4)</sup>.
- The scalp electrode is placed 2 cm posterior to the standard Cz (designated Cz') according to the 10/20ESIF<sup>(1,4)</sup>.
- A ground electrode is placed between the stimulating point and the 1<sup>st</sup> recording point at the crease of the popliteal fossa <sup>(1)</sup>.

(ii) Electrode Choice

Electrodes used to record a SSEP are the same used for EEG recording <sup>(1,4)</sup>. The electrodes used should also be of the same material preferably silver / silver chloride (Ag/AgCl), or gold plated silver due to the inherent time constant of each material <sup>(5,4)</sup>.

(iii) Electrode Impedance

Electrode impedance should be measured prior to each recording and at any time during the SSEP where an electrode has been altered or adjusted. Impedances of all electrodes should measure below 5kohms<sup>(1, 5)</sup> and of a similar value within no more than 3kohm range of each other <sup>(4)</sup>.

## 5. MACHINE PARAMETERS

### (i) Common Mode Rejection Ratio

For common mode rejection to work effectively the active and reference electrodes should be of near equal impedance<sup>(4)</sup> and all input electrode impedances maintained below 5Kohms<sup>(1, 5)</sup>.

The amplifier's common mode rejection ratio should be 80dB<sup>(6)</sup> or greater<sup>(8)</sup>.

### (ii) Input Impedance of Pre-amplifiers

The amplifier's input impedance should be at least 100MΩ<sup>(6, 8)</sup>.

### (iii) Analogue to Digital Signal Conversion

The sample rate should be a minimum of 500 samples per second per channel with a minimum resolution of 8bits<sup>(1, 4)</sup>.

### (iv) Automatic Artefact Rejection

For SSEPs, automatic artefact rejection should be employed to eliminate high amplitude transients<sup>(1, 4)</sup>.

### (v) Filters

For the purpose of SSEP's filters should be set to the following levels<sup>(1, 4)</sup> –

Low Pass/High Frequency Filter  $\geq$  2.5k-3kHz (-3dB)

High Pass/Low Frequency Filter  $\leq$  1-30Hz (-3dB)

The use of the 50Hz 'notch filter' is strongly discouraged. Any applicable artefact should be rectified by addressing the source of the interference, such as nearby electrical equipment or the recording electrodes<sup>(1)</sup>.

### (vi) Sweep Duration

Generally 50ms post stimulus for upper limb and trigeminal nerve recordings and 100ms for lower limb recordings, including cutaneous nerve of the thigh, in adults is sufficient however if major response components are significantly prolonged or delayed a longer analysis time may be required to obtain reproducible results<sup>(1)</sup>.

### (vii) Averaging

At least 250 -500 individual trials to be averaged – more may be required (up to 2 000) to ensure reproducibility in low amplitude responses and to ensure that a stable waveform is recorded with minimal noise<sup>(1,4)</sup>.

At least two total runs should be obtained and superimposed to verify reproducibility of waveform morphology, latency and amplitude<sup>(1,4)</sup>.

## 6. RECORDING

Ensure the patient is relaxed, in a position that ensures patient's comfort and minimises muscle activation. Monitor the quality of the live/raw data while averaging the signal to ensure integrity <sup>(1)</sup>.

### (i) Patient and Test Information

The following details should be included, with any SSEP recording:

- Patient name
- Patient identification number
- Date of birth
- Recording date
- Referring doctor
- Recording health professional initials
- Relevant Clinical Details
- Clinical question to be answered
- Current medications
- Height of the patient (lower limb SSEP)
- Time and amplitude scale
- Number of averaged trials
- Montage
- Polarity convention.

Height (and arm length if used) is measured in accordance with normative data collection <sup>(1)</sup>.

### (ii) Patient Attention

Level of alertness does not affect the SSEP<sup>(1)</sup>. The patient may be awake, drowsy or asleep during the recording of the SSEP. Sedation may be required for uncooperative/tense patients<sup>(4)</sup>.

### (iii) Stimulus Site

Stimulation site for the SSEP should be placed at the best accessible peripheral site of the appropriate nerve.

Do not apply stimulation electrodes over or adjacent to central lines or wires that are connected to the heart or large vessels <sup>(1)</sup>.

### (iv) Stimulus Type

Monophasic square-wave electrical pulses should be delivered, preferably by a constant current stimulator <sup>(1)</sup>.

### (v) Stimulus Rate

Stimulation rate should be 2–5 Hz <sup>(1,4)</sup>.

- (vi) **Stimulus Duration**  
The duration of the stimulus should be 0.1 – 0.2ms<sup>(1)</sup>.
- (vii) **Stimulus Intensity**  
The stimulus intensity should be sufficient to produce a visible twitch in the intrinsic hand or foot muscles supplied by the nerve <sup>(4)</sup> (median, ulnar, tibial, peroneal) or 2-3 times the level of sensory threshold (radial, sural)<sup>(4,1)</sup>. See specific stimulation intensity detail for cutaneous nerve of the thigh and trigeminal nerve below (x, xi).
- (viii) **Upper Limb Nerve Stimulation**  
The upper limb stimulation site is best placed with the cathode 2cm proximal to the wrist crease<sup>(1)</sup> over the median or ulnar nerve and at the anatomical snuff box over the radial nerve<sup>(4)</sup>. The anode lies 2cm distal to the cathode over the wrist crease<sup>(1)</sup>.

- a) **Example of Upper Limb SSEP Montages <sup>(1,7)</sup>:**

Channel 1: Erb’s Point Fz	Channel 1: Erb’s Point (EP) - Fz
Channel 2: Cervical -Fz	Channel 2: Cervical 7 (C7) - Fz
Channel 3: Contralateral scalp –Erb’s Point	Channel 3: Cervical 2(C2) - Fz
Channel 4: Contralateral scalp - Fz	Channel 4: Contralateral scalp-Fz
Ground: Forearm	Ground: Forearm

The order of channel displayed may vary according laboratory preferences.

- b) **Upper Limb SSEP Markers <sup>(1,4,3,7)</sup>:**
  - Peak latency
    - EP- negative peak recorded from Erb’s Point approximately 9ms after the stimulus
    - N13-negative peak recorded from C2 approximately 13 ms after the stimulus
    - N20-negative peak recorded from contralateral scalp approximately 20ms after the stimulus.
  - Inter-peak latency      EP-N13, N13-N20
  - Baseline to peak amplitude:      EP, N13, N20

- (ix) **Lower Limb Nerve Stimulation**  
The lower limb stimulation site for
  - the posterior tibial nerve is best placed at the medial ankle with the cathode midway between the medial border of Achilles tendon and the posterior border of the medial malleolus <sup>(1, 4)</sup>
  - the common fibula (common peroneal) nerve is best placed with the cathode about halfway between the medial and lateral malleolus on the dorsal part of the ankle between the extensor digitorum longus and extensor hallucis longus tendons the sural nerve is best placed at the lateral ankle with the cathode

midway between the lateral border of the Achilles tendon and the posterior border of the lateral malleolus.

The anode is placed 2 cm distal to the cathode<sup>(4,1)</sup>.

a) Example of Lower Limb Montages <sup>(1, 4, 7)</sup>:

Channel 1: PF – PF'	Channel 1: PF-PF'
Channel 2: L1(2,3)- IC	Channel 2: L1(2,3) -IC
Channel 3: Cz' - Fz	Channel 3: Cz-Fz
	Channel 4: Cz' - Fz
Ground: Shin	Ground: Shin

b) Lower Limb SSEP Markers <sup>(1, 4, 7)</sup>:

Peak latency

PF- negative peak recorded from popliteal fossa approximately 9ms after the stimulus

N20-negative peak recorded from L1(2,3) approximately 20 ms after the stimulus

P37-positive peak recorded from cortex (Cz') approximately 37ms after the stimulus

N45-negative peak recorded from the cortex (Cz') approximately 45ms after the stimulus

Inter-peak latency L1(2,3) – Cz'

Baseline to peak amplitude: PF, N20, P37



## 7. QUALITY CONTROL

### (i) Normal Values

Each lab should establish its own normative data using standard stimuli and recording parameters <sup>(4)</sup>.

Recording parameters such as stimulus type should be the same for all patients tested and for all subjects from which normative data is obtained <sup>(4)</sup>.

Normative values from other institutions or sources may only be utilised if equivalent stimulation and recording parameters are employed and only after testing the validity of the adopted normal values on at least 10 locally gathered subjects under normal recording conditions <sup>(4)</sup>.

Note that normative values may be influenced by age, gender and height of the patient and that acquired normative data for adults must be in a given age and height range. For tibial SSEP normal values are strongly related to height and height related normal values are strongly recommended. Additional normative data may need to be acquired for elderly (>60) or paediatric (<5) populations <sup>(4, 7)</sup>.

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## Appendix 1 - Stakeholders

### Stakeholders

- ANTA Inc. Members
- Document Development Committee
- Document Development Committee Advisory Group
- Other interested parties

### Original Document

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ANTA Inc Executive: Stephanie Brooks, Anna Exley, Justin Stent 2009.

Endorsed by ANTA Inc Members (2010).

First Revision – 2012

### Document Development Committee

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### Advisory Committee

The document development committee identified a group of key stakeholders to view the draft documents for feedback. The advisory group was made up of technologists, scientists and neurologists working in the neurophysiology industry around Australia. The comments from this group were considered, compared against the reference material and included where appropriate.

### Members Feedback

On completion of the final draft the document was put out to all members of ANTA Inc. for feedback. The comments from members were considered, compared against the reference material and included where appropriate.

### Guideline Acceptance

This Guideline was accepted by members in July 2014.

### Amendments

2016 May      Disclaimer and Copyright statements added.  
2023 July      Rebranded to ANSA Inc

## Appendix 2 – Lateral and Medial Thigh SSEP <sup>(9)</sup>

There is limited published data on the lateral and medial thigh SSEP. The following information includes suggested machine parameters and electrode placement. Unless clinical neurophysiology staff is familiar with performing and interpreting the test, the potential for obtaining unreliable recordings and for misinterpretation is high and its use is not recommended.

### 1 Recording Electrodes

The scalp recording electrode is placed 2 cm posterior to the standard Cz (designated Cz') according to the 10/20ESIF.

Additional recording electrodes can be placed 2cm either side of Cz' (designated RCz' and LCz') if available recording channels allow

The scalp reference electrode is placed at Fz.

### 2 Stimulation

#### a) Stimulation Site

- For lateral thigh stimulation the cathode is placed 20-25cm distal to the Iliac Crest lateral to the midline of the thigh. The anode is placed 10-15cm distal the cathode.
- For medial thigh stimulation the cathode is placed 20-25cm distal to the iliac crest medial to the midline of the thigh. The anode is placed 10-15cm distal the cathode.

b) Stimulation Intensity: 2-3 times the sensory threshold and lower than for visible muscle contraction.

### 3 Recording

#### a) Example Lateral and Medial Thigh SSEP Montage:

Channel 1: Cz - Fz

Channel 2: Cz' – Fz

Channel 3: RCz' - Fz

Channel 4: LCz' - Fz

Ground: Midline of the thigh

#### b) Lateral and Medial Thigh SSEP Markers:

Peak latency

P35 - positive peak recorded from scalp Cz and Cz'

N40 - negative peak recorded from scalp Cz and Cz'

Base to peak amplitude P35

### Appendix 3 - Trigeminal Nerve SSEP <sup>(10, 11)</sup>

There is limited published data on the trigeminal SSEP. The following information includes suggested machine parameters and electrode placement. Unless clinical neurophysiology staff is familiar with performing and interpreting the test, the potential for obtaining unreliable recordings and for misinterpretation is high and its use is not recommended.

#### 1 Recording Electrodes

The scalp electrodes are placed midway between C4(C3) and T4(T3) in accordance with placements C6 and C5 from the 10/20 ESIF. The scalp reference electrode is placed at Fz.

#### 2. Stimulation

##### a) Stimulation Site

Electrodes are placed on at the corner of the mouth on the upper and lower lips.

b) Stimulation Intensity: 2-3 times the sensory threshold and lower than for visible muscle contraction.

#### 3. Recording

##### a) Example Trigeminal Nerve SSEP Montage:

Channel 1: C5 - Fz for stimulation to the right side

C6 - Fz for stimulation to the left side

##### b) Trigeminal Nerve SSEP Markers:

Peak latency

N13 -negative peak recorded from contralateral scalp

P19 - positive peak recorded from contralateral scalp

N26 -negative peak recorded from contralateral scalp

Baseline to peak amplitude                      P19

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