ORIGINAL ARTICLE
DOI: 10.15713/ins.bhj.186

Radial SNAP- Optimal Site of Stimulation in Healthy Indian Subjects

ABSTRACT

Background: The radial sensory nerve action potential (SNAP) is an important electrodiagnostic study of the upper limbs for a large variety of conditions. Inappropriate distance of stimulation and unavailability of reference data can lead to erroneous conclusions.

Objectives: To establish the optimal site of recording the Radial SNAP and obtain reference data for radial SNAP in age-stratified healthy subjects.

Materials and Methods: A prospective study was conducted in 181 nerves from healthy subjects aged between 18 years and 86 years, stratified into five groups as per age: a = 18-30 years, b = 31-40 years, c = 41-50 years, d = 51-60 years, e > 61 years. Radial SNAP was recorded antidromically, stimulating at 10 cm from the recording electrode. Mean – 2 standard deviation (SD) of the transformed data was used to generate reference values for amplitudes.

Results: The lower limits of amplitude at 10 cm were 28.8, 30.4, 24.4, 23.7 and 16.2 µV for groups a, b, c, d and e, respectively and at 12 cm were 25, 29.2, 18.9, 17.9 and 14.5 µV respectively. A statistically significant difference in amplitudes was noted from the three different sites of stimulation ($P < 0.001$). A 17% variation in amplitude is explained by age. Height, BMI and wrist girth had minimal effect on the amplitude obtained ($r2= 0.05, 0.01, 0.00$)

Conclusion: This study provides age stratified reference data for antidromic Radial SNAP in Indian population and also gives the optimal site of stimulation of the SNAP.

Key words: Radial SNAP, amplitude, antidromic, age-stratified

INTRODUCTION

Radial nerve is the largest nerve in the upper limb. It arises from the posterior cord of the brachial plexus. Apart from widespread innervation to the upper limb muscles, the Radial nerve gives off multiple sensory branches in the arm and forearm. The posterior cutaneous nerve of arm & lower lateral cutaneous nerve of arm are the cutaneous branches in the arm. The posterior cutaneous nerve of forearm and superficial radial nerve are the cutaneous branches in the forearm. The superficial radial sensory nerve action potential (SNAP) study has a vast utility ranging from evaluation of upper limb nerve trauma as the nerve is very superficial, brachial plexopathies, pressure palsies, part of mononeuritis multiplex, apart from a very significant role in the evaluation of peripheral neuropathies.(1,2,3)

The superficial radial nerve lies deep to the Brachioradialis muscle until approximately two thirds the way down in the forearm. The nerve lies deep to the extensor carpi radialis longus muscle. Between the "fork" of separation of the ECRL and brachioradialis muscles in the distal forearm, the nerve becomes subcutaneous. The nerve then courses to the dorsal aspect of the wrist and gives off branches on the dorsolateral aspect of the hand.(3,4,5,6)

As a pilot study, we did random measurement of the forearm length from radial styloid to elbow crease, along the lateral border of the forearm in 10 male and 10 female healthy subjects of varying heights. The mean forearm length was about 25 cm which implies that the site of stimulation would be around 50% into the forearm when stimulating at distances of >10 cm. At this site, the superficial radial nerve would be deep to the Brachioradialis muscle, implying that stimulating at this site may result in falsely low amplitude recordings of the SNAP.(6,7)

Using this assumption, we conducted a study of Radial nerve SNAP recorded at 10 & 12 cm stimulation distances from the active electrode in healthy subjects and age stratified the data to use as normal controls.

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MATERIAL AND METHODS

This was a prospective study, which was conducted in the department of Clinical Neurophysiology of a tertiary hospital. The study was approved by the institutional ethics committee.

Subjects selected included:

- Healthy volunteers
- Healthy relatives accompanying patients
- Patients referred for the test for unrelated conditions restricted to the lower limbs

Exclusion criteria

- Subjects with paraestheisae or numbness in the lower or upper limbs
- Subjects with Diabetes Mellitus or history of any other systemic illness in the past or any long term treatment for any condition
- Subjects with history of alcohol or tobacco consumption
- Upper limb symptoms suggestive of radiculopathy/ entrapment neuropathy/ plexopathy
- History of trauma or fracture to the upper limb, even if in the past

All the selected participants were examined clinically to exclude any sensory deficits and had normal deep tendon reflexes in the upper limbs. Age, weight, height and wrist girth at 10 and 12 cm stimulation sites of all patients were recorded. Body mass index (BMI) was calculated as weight (kg)/ Height in m^2

One hundred and eighty-one healthy subjects between the age group of 18-86 years were included of which 91 were males and 90 females. Written and informed consent was taken from the subjects for participating in the study. Getting recordings from healthy subjects over the age of 80 years was difficult.

Technique of Superficial Radial nerve SNAP recording

The recording procedure was explained to the subject in detail to ensure maximum comfort and cooperation. The recordings were done on a Natus Ultrapro electromyograph. The filter settings were kept between 20 Hz to 2 kHz. The acquisition parameters used were a sweep speed of 20 ms and amplitude gain of 10μV/ division. Same test protocol and machine settings were used by neurophysiologists trained at the same centre. Upper limb temperature at wrist was recorded using a testo skin thermometer and maintained at 32° C throughout the test.

Subject was asked to lie down comfortably in the supine position with the hand by the side with the palm facing towards the body (Figure 1). The recording and stimulating sites were cleaned to reduce skin impedance. Self-adhesive stick-on electrodes were used to record the SNAP. The active recording electrode, E_1 was placed at the anatomic "snuffbox" and the reference electrode, E_2 was placed 3 cm distally on the dorsum of the thumb. The superficial Radial nerve was stimulated at 2 sites, 10 and 12 cm proximal to the active recording electrode, E1, over the lateral border of the Radius. The ground electrode E0, was placed in between the recording and stimulating sites. Supramaximal stimulus was given to obtain the maximum SNAP amplitude. The stimulating electrode was gently glided from medial to lateral aspect at the stimulation site to obtain maximum amplitude of the SNAP.[8,9] Care was taken to avoid a large stimulus artifact and volume conducted motor response following the SNAP by reducing the stimulus strength but not affecting the amplitude of the response. The optimal SNAP was then averaged for about 8 responses and 2 trials were done to replicate the responses. For the averaged SNAP, the onset latency in milliseconds was measured from the onset of the sweep to the onset of the negative peak of the waveform. The peak-to-peak amplitude was measured in microvolts.

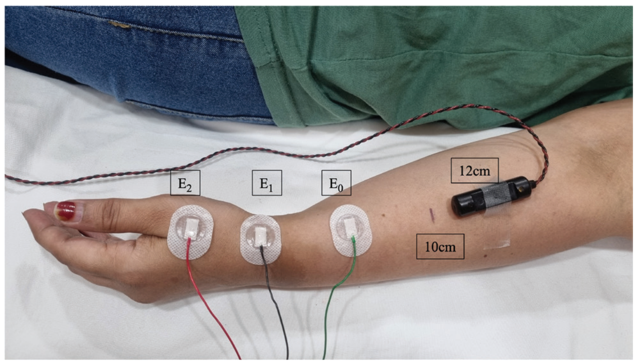

Figure 1: Antidromic Radial SNAP recording at 10 cm and 12 cm

Statistical analysis

All data was analysed using the Stata Corp 12.2 (Stata Corp LP, College Station, Texas) statistical program. The parameters of the Right upper limb were included for statistical analysis, using total 181 nerves. The subjects were stratified into five groups as per age: a = 18-30 years, b = 31-40 years, c = 41-50 years, d = 51-60 years, e > 61 years.

The coefficient of skewness was calculated for the latencies and the amplitude of the Radial SNAPs recorded at distances of 12 cm and 10 cm from E1. The latency values showed a Gaussian distribution, however, the values for the radial amplitudes were positively skewed ($p = 0.0014$ at 12cm and $p = 0.003$ at 10 cm) and required optimal transformation.

Statistical analysis for obtaining reference values was done using mean +/- 2SD as suggested by Robinson et. al.[10] The percentile and quantile regression methods could not be applied to our study as the sample size in each group was not adequate.

Mean + 2SD was taken to define the upper limit of the Radial latency at 10 cm. The amplitudes obtained at each stimulation site were transformed by squaring to bring the positively skewed data into a more Gaussian distribution ($p = 0.44$ at 12 cm and $p = 0.16$ at 10 cm). The mean -2 SD of the transformed data was then computed and then reconverted into the original units for the lower limit of the SNAP amplitude at both sites of stimulation.

The transformed radial amplitudes at each stimulation sites of 12 cm and 10 cm were compared using the paired t test for statistically significant difference at the 2 sites of stimulation.

ANOVA was applied to compute the statistical difference in the Radial amplitudes between each of the groups specified in order to assess the effect of age on amplitude. Further linear regression was done by model building to assess the effect of age, height, BMI, wrist girth on the amplitude of the Radial SNAP.

RESULTS

One hundred and eighty one right radial nerves of healthy subjects (91 males and 90 females) between the ages of 18 and 86 years were included in the study. The anthropometric parameters of the subjects are as shown in table 1

Table1: Anthropometric parameters of the subjects in the study

Variable	Mean	SD	Minimum	Maximum
Age (years)	47.04	16.57	16	86
Weight (kg)	64.83	12.82	39	114
Height (in m)	1.61	.09	1.325	1.88
BMI- weight in kg/ height in m2	24.96	4.63	15.62	38.28
Wrist girth at 12 cm	20.10	2.24	13	25
Wrist girth at 10 cm	18.63	2.12	12	24

SD: Standard deviation

Two sample t test showed no significant differences in the radial SNAP amplitudes at each site of stimulation for males vs females (effect <0.2 as a difference of the SDs). Hence, further analysis was carried out after pooling the data for both genders.

The reference data for radial SNAP onset latency and peak -to-peak amplitude were calculated for each age group at distances of 12 cm and 10 cm from the recording electrode and are listed in table 2

Table 2: Reference data for Radial SNAP

Lower limit of Normal	18-30 years	31-40 years	41-50 years	51-60 years	> 61 years
Amplitude at 12cm	25	29.2	18.9	17.9	14.5
Amplitude at 10cm	28.8	30.4	24.4	23.7	16.2

SNAP: Sensory Nerve Action Potential

Paired t test detected a statistically significant effect dependent on the site of stimulation from recording electrode ($t(180) = -13.2$, $p < 0.001$)

Linear regression of the transformed amplitude data showed age as the covariate with maximum effect ($r2 = 0.16$) (Figure 2)

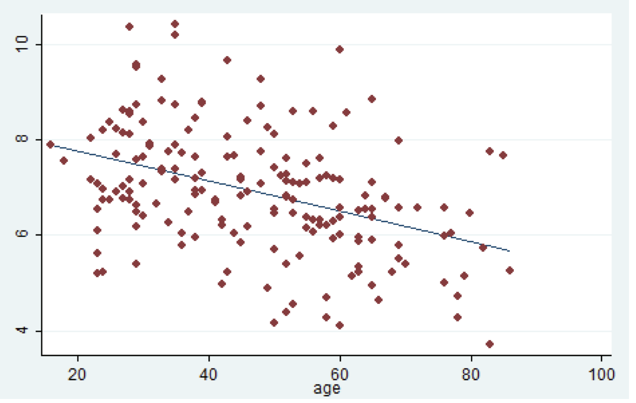

Figure 2: Linear regression of the transformed amplitude data showing age as the covariate with maximum effect

One way ANOVA to compute statistical difference in radial SNAP amplitude between age groups was significant for between groups ($F4, 176= 9.47$, $p < 0.001$)

Using Bonferroni multiple comparison correction, statistical significance in amplitudes was detected between groups a & d, b & d, a & e, b & c ($p < 0.05$) Amplitudes between age groups c & d, c & e did not show statistically significant differences.

Further using eta squared r2, a 17% variation in amplitude is explained by age.

Height, BMI and wrist girth had minimal effect on the amplitude obtained (r2= 0.05, 0.01, 0.00)

The statistical power of our study was estimated to be 0.8

DISCUSSION

The radial SNAP is a commonly recorded upper limb SNAP for a large number of conditions including traumatic/ non traumatic neuropathies / plexopathies as well as generalized / widespread peripheral neuropathies/ mononeuritis multiplex . Abnormalities of the radial SNAP are detected by comparing primarily the amplitude of the SNAP to the available reference data as well as comparison to the opposite side.

Ascertaining reference data for Radial SNAP is important for 2 reasons: a) to establish age stratified data, and b) to ascertain the optimal distance for recording maximum amplitude.

There is a dearth of studies which establish age stratified normative data of the antidromically recorded radial SNAP. [11]

Our study shows that there is a significant difference in the amplitude of the SNAP when recorded at the different sites. This becomes especially important while doing side to side comparison as well as during follow up studies.

The studies by Chang, Oh et.al, Evanoff & Buschbacher, Kumar & Jose and Chouhan, give the reference values of the latencies and amplitudes of the Radial SNAP but does not give age stratified values.[12,13,14,15]

Also, if the data is not age stratified, the range of upper and lower limits of the radial SNAP amplitude is very wide, as in the study by Benater et al (7.5- 123 μV) and does not serve adequate clinical utility.[15,16]

As expected, the SNAP amplitude regressed negatively with age and there was a significant difference in the older age groups as compared to the younger age groups. The correlation of the radial SNAP amplitude with age as well as distance has not been established in any study.

In our study, we have utilized the mean +/- 2 SD method after transforming the skewed data as suggested by Robinson et al.[10] Many studies use percentile methods for establishing the lower limit of normal of the SNAP amplitude. However the sample size of each group in our study was inadequate to reliably apply the same methodology. A shortcoming of our study is inclusion of subjects only from a single centre. A larger, multicentric study from other geographical areas could be planned with larger number of subjects.

CONCLUSION:

This is the first Indian study to give age stratified reference data for recording the Radial SNAP at 10 am and 12 cm stimulation distances from the active recording electrode. This study also shows the wide variation in amplitude of the SNAP at different distances of stimulation. We here present age stratified normative data of the amplitude at fixed distance of stimulationto eliminate error due to any of these.

How to cite this article: Sharma A, Chavan P, Mansukhani KA, Nagaonkar PA. Radial SNAP- Optimal Site of Stimulation in Healthy Indian Subjects. Bombay Hosp J 2024;66(4):4-7.

Conflicts of Interest: None. **Source of Support:** None.

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