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RESEARCH ARTICLE
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"RELIABILITY AND VALIDITY OF SENAUDI KIT IN POST STROKE PATIENTS"

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Abstract: Stroke shows its impact on ability to function independently and on overall quality of life. Along with the motor functions, sensation is also impaired in half of the stroke patients which shows long term affect to use the upper limb in daily life.
The sensory information enters the spinal cord through the dorsal roots. Sensory signals are then carried to higher centres via ascending pathways from one of two systems: they are anterolateral spinothalamic system or the dorsal column-medial lemniscal system.
Somatosensory cortex: the most complex processing of sensory information occurs in the somatosensory cortex, which is divided in to three main divisions primary somatosensory cortex, secondary somatosensory cortex, and posterior parietal cortex. A few studies have reported that static stretching is more effective than neural slump stretching in increasing the range of motion.
Talking about active sensory assessment in which patients actively touch the object and feel it in which proprioception and tactile information are integrated during intended hand movement. As active touch is an essential element in the process of tactile learning after stroke.
In a study about 69% of stroke participants have loss of sensory function in the more affected hand, and 44% in the less affected hand and 20% in both hands according to STI test.
SenAudi Kit is effective in assessing sensory impairments of post-stroke patients of all durations.

Keywords: SenAudi Kit, STI test (shape and texture identification test), Sensory impairment of upper limb, Post stroke patients.

Introduction

Stroke shows its impact on ability to function independently and on overall quality of life. Along with the motor functions, sensation is also impaired in half of the stroke patients which shows long term affect to use the upper limb in daily life.

The neural pathways that conduct information from the receptors to the brain therefore the ascending tract or sensory tracts in the spinal cord. The sensory information that reaches the consciousness is called sensation. The understanding and awareness of the sensation meaning is called perception eg: pain is a sensation but its awareness is a perception.
The ability of an individual to move smoothly depends on the flexibility, an attribute that enhance both safety and physical activities[3].

Anterolateral spinothalamic pathway: the spinothalamic tracts are diffuse pathways concerned with non-discriminative sensations such as pain, temperature, tickle, itch etc. especially anterior spinothalamic tract carries the sensations of crudely localized touch and pressure, and lateral spinothalamic tract, which carries pain and temperature and the spinoreticular tract which is involved with diffuse pain sensations. this system is activated primarily by mechanoreceptors, thermoreceptors, and nociceptors, and is composed of afferent fibers that are small diameter and slowly conducting (5).

Dorsal column-medial lemniscal pathway: this system is responsible for the transmission of discriminative sensations received from specialized mechanoreceptors. Sensations that are carried by this pathway are discriminative touch, stereognosis, tactile pressure, barognosis, graphesthesia, recognition of texture, kinesthesia, two-point discrimination, proprioception and vibration. This system is composed of large, myelinated, rapidly conducting fibers (5).

Evidences indicated that primary motor cortex area cannot be consider solely as a motor structure rather, it is involved in the processing of somatosensation via its anatomical and functional connections with primary and secondary somatosensory cortices, and also with the sensory thalamus (8).
Stroke is the leading cause of serious long-term disability (2). Sensation is commonly impaired after stroke, sensory impairments are associated with stroke severity, decreased motor function, and are prognostic factor for treatment outcomes (3). 47% had touch discrimination impairment on affected hand of stroke patients, contralateral to the lesion and 16 % experienced impairment on ipsilesional unaffected hand (4). 49% showed impaired proprioception in the affected limb and 20% on unaffected limb (4).

To assess sensory functions of patient commonly used scales are fugl-Meyer and STI test one is a passive assessment tool and the other is active assessment of sensory functions.

Talking about active sensory assessment in which patients actively touch the object and feel it in which proprioception and tactile information are integrated during intended hand movement. As active touch is an essential element in the process of tactile learning after stroke (1).

We have designed a new assessment tool SenAudi kit which is used to assess the active touch (Sensory functions assessment test) in patients and also used in treatment. (Sen- means sensory, Audi- means auditory cues used in the sensory training). The kit contains two subtests one is texture identification in which we have used real textures like cotton, silk, wool, sand paper etc. as we have used wide variety of textures it will increase complexity in identifying and differentiating different textures and second subtest is of shapes identification like circle, triangle, square, hexagon. In shape identification we have followed order of three-cornered shape, four cornered then six cornered but did not jump direct to six cornered after four cornered shapes. This will give a clear idea of patient's identification of shape and it won't affect patients score during assessment (as we have observed jumping of shapes without order in STI test).

Procedure and Method
Source of Data Collection: Department of physiotherapy, Himalayan Institute of Medical Sciences (Swami Rama Himalayan University).
Sample size: 30 patients
Procedure and Protocol:
Material used:
SenAudi kit.
Shape and texture test.
Test sheets of SenAudi kit and STI test

Blind folder/ cloth.
Table and chair.

Methodology:
Prior to the inclusion, information about the purpose of the study was provided and each individual gave his or her written consent to participate. The subjects who are meeting the inclusion criteria were assessed for sensory function in affected and unaffected upper limb with SenAudi kit and STI test by observer 1 followed by observer 2 in the same circumstances, on the same day
Assessing with SenAudi kit :
This kit consists of two subtests 1.) texture identification (we used different rough textures like spine texture, nodular texture, sand paper texture, denims cloth texture etc. and different smooth textures like wool texture, ribbon texture, velvet texture) 2.) shape identification (shapes like circle, triangle, square, and hexagon).
As an initial step subject is asked to open the eyes and observe all the textures and shapes of the SenAudi kit with unaffected hand later with affected hand by using the pulp of the index finger to identify the texture and shape. He/she should not use finger nail during identifying, in the second step subject is asked to close the eyes and feel the texture, identify and answer to the therapist, there are total five rounds each round has time limit of 15 sec to identify the textures and shapes, if the subject is not able to identify the texture/shape for the first time. For correct answer in each round subject is given one point for each texture and shape. The total score of texture is 40 and total score of shape is 20 combining both texture and shape scores the final score of SenAudi kit is 60 (Max score). According to the score obtained by the subject gradings are given like 0-10 very poor performance, 10-25 poor, 25-30 fair, 30-45 good, 45-50 very good, 50-60 excellent performance.

Figure – 1: showing stroke patient identifying the shapes and textures of SenAudi Kit.

Assessing with STI test (shape and texture test) :
STI test consist of two subtests: a) identification of three shapes (cube, cylinder, hexagon) and b) identification of three textures (one, two, or three raised metal dots placed in a row). The test includes three difficult levels: decreasing size of the shapes (15 mm, 8mm, 5mm) and decreasing size and distance between dots (15mm, 8mm, 4mm). The participants were seated in front of the therapist and asked to feel the shapes and textures with eyes open. the shape and texture are of three different sizes. The identification was performed with the pulp of index finger with instruction not to use the nail. First the shapes of 15mm were exposed to the less affected hand, followed by the shapes of 8mm and 5mm in size. The texture were exposed in the same way. Once the trail is finished now subject is asked to close the eyes and repeat the same process now the scoring is done and there is no time limit to identify the shape and texture of all three different sizes. The score of the STI test ranges from 0 to 6 points per hand, and 0 to 3 points (one point for each size) for each subtest. 3 correctly identified textures/shapes = 1 point, 1-2 correct identification = 0 points, maximum score for the complete test = 6 point (3).

Figure – 2: Showing, Explaining the test to the stroke patient.

Figure – 3: Showing stroke patient identifying shapes and textures of STI Test.

Figure – 4: Showing SenAudi Kit with different shapes of 15mm and different rough and smooth textures.

Figure – 5: showing SenAudi kit/Box with AC/DC usage for production of auditory cues which can be used in Sensory integration therapy.

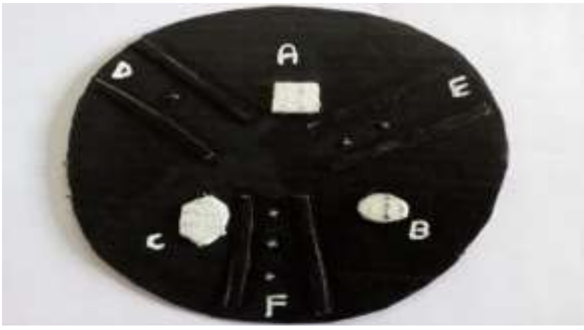


Figure – 6: showing STI test with size of 15mm shape and texture with distance of 15mm.

Figure – 7: showing STI test with size of 15mm shape and texture with distance of 8mm.

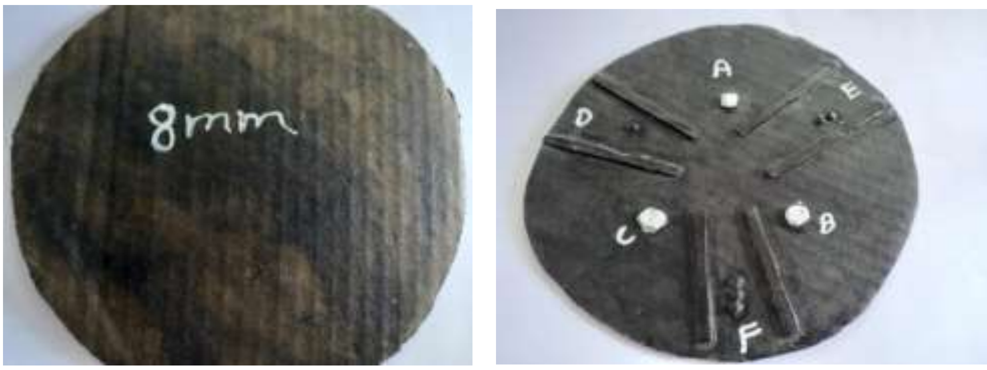


Figure – 8: showing STI test with size of 8mm shape and texture with distance of 8mm.

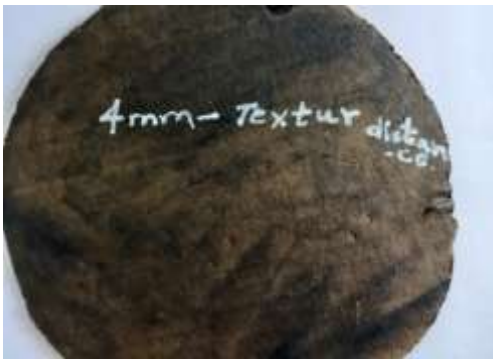


Figure – 9: Showing STI test with size of 5mm shape and texture with distance of 4mm.

Result and Statistical Analysis:

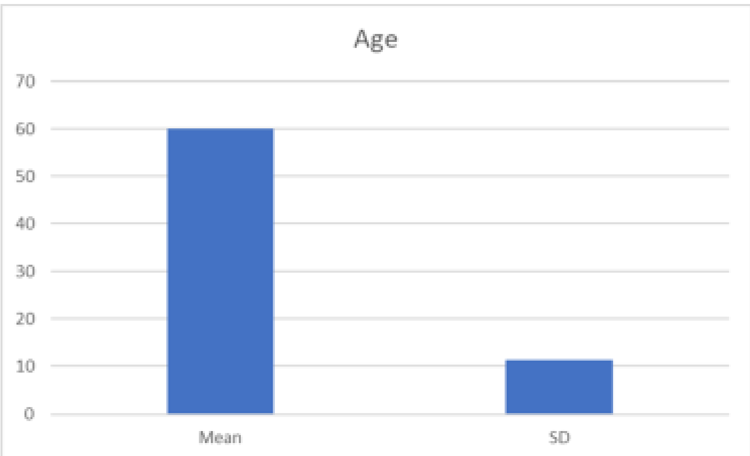
Table-1: showing number of male and female stroke patients in Study

Sex	
Male	18
Female	12

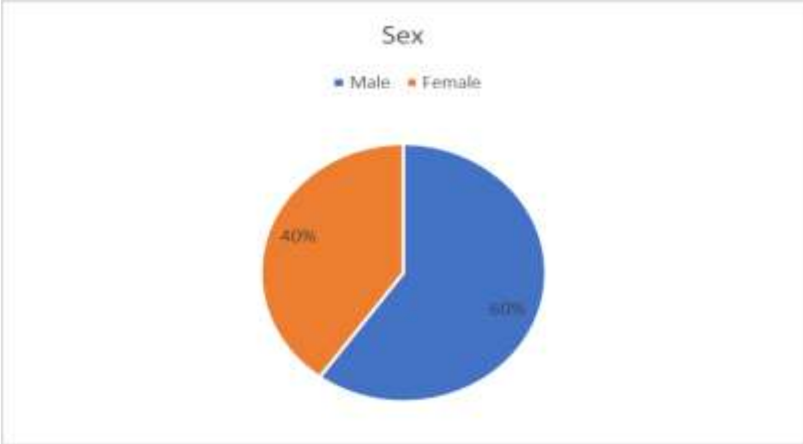
Table-2: Showing mean, standard deviation, standard error, mode, median, sample variance, kurtosis, skewness, range, minimum, maximum values of thirty stroke patients who participated in study.

Age of thirty stroke patients	
Mean	60.06666667
Standard Error	2.075546367
Median	62.5
Mode	70
Standard Deviation	11.36823564
Sample Variance	129.2367816
Kurtosis	0.020520075
Skewness	-0.763401843
Range	46
Minimum	31
Maximum	77
Sum	1802

Thirty persons (18 males, 12 females) with acute, subacute and chronic stroke and mild to moderate impairments in their arm and hand participants in the study. Their mean age is (60.666) and standard deviation was (11.368) years, median was (62.5), mode was (70), sample Variance was (129.236), kurtosis was (0.020) and skewness (-0.763), range was (46), minimum (31), maximum (77), sum is (1802).



Graph- 1: showing mean and standard deviation of age



Graph- 2: Showing percentage of male and female patients of stroke in study.

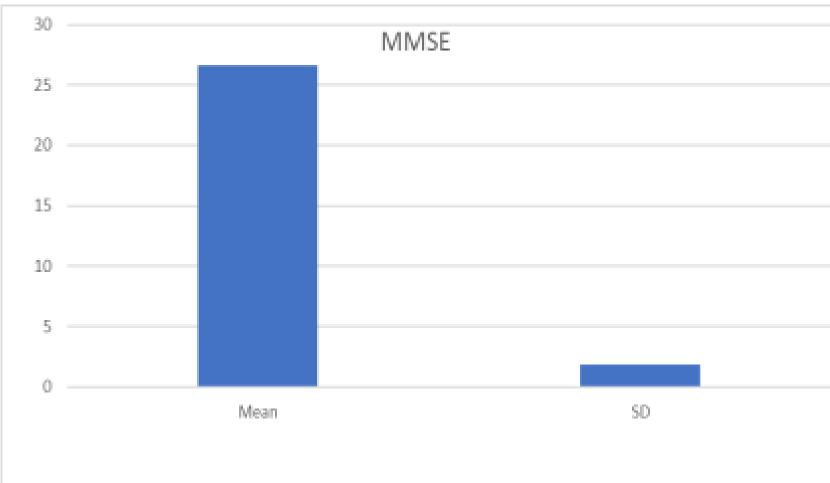
Table-3 : Showing number and type of stroke patients in the study

Type of stroke	
Cerebral haemorrhage	11
Cerebral Infarction	19
Sum	30

Table-4 : Showing mean, Standard Deviation, Standard error, Median, Mode, Sample Variance, Kurtosis, Skewness, Range, Minimum, Maximum of MMSE Scores of stroke patients in study.

MMSE (Mini Metal State Examination) of thirty stroke patients participated in study.	
Mean	26.6
Standard Error	0.341
Median	28
Mode	28
Standard deviation	1.868
Sample Variance	3.489
Kurtosis	-1.651
Skewness	-0.525
Range	5
Minimum	24
Maximum	29
Sum	798

The mean of MMSE score is (26.6), Median was (28), Mode was (28), Standard Deviation (1.868), Standard Error was (0.341), Sample variance was (3.489), Kurtosis was (-1.651), Skewness was (-0.525), Range was (5), Minimum was (24) , Maximum was (29), the Sum was (798).



Graph-3: Showing mean and standard deviation of MMSE Scores of stroke patients.

Table-6: showing mean value of fugl-meyer sensory function score of stroke patients in study

Mean of fugl-meyer sensory function score of stroke patients in study :	
Unaffected hand	11.46
Affected hand	8.53

Table-7: showing kappa coefficient (%) of fugl-meyer sensory function score of stroke patients in the study

Kappa coefficient (%) of fugl-meyer sensory function score of stroke patients in the study :	
Unaffected hand	14.20%
Affected hand	46.40%

Table-8: showing mean of voluntary muscle control score of stroke patients in the study

Mean of voluntary muscle control score of stroke patients :	
Unaffected hand	3.56
Affected hand	2.84

Table-9: Showing kappa coefficient (%) of voluntary muscle control score of stroke patients.

Kappa coefficient percentage agreement (%) of voluntary muscle control score of stroke patients :	
Unaffected hand	89.20%
Affected hand	92.80%

Table-10: showing mean of SenAudi Kit score of stroke patients in the study :

Mean of SenAudi Kit score of stroke patients in the study :			
Unaffected hand		**Affected hand**	
Observer- 1	**Observer- 2**	**Observer-1**	**Observer-2**
58.86	58.1	52.93	53.46

Table-11: Showing Mean of STI test score of stroke patients in the study :

Mean of STI test score of stroke patients in the study :			
Unaffected hand		**Affected hand**	
Observer-1	**Observer-2**	**Observer-1**	**Observer-2**
5.13	5.4	3.5	3.9

Table-12: Showing kappa coefficient of SenAudi Kit Unaffected hand score by Observer-1 and observer-2:

	UA1	UA2	
UA1	1		
UA2	0.721243	1	positive
	High		

Table-13: Showing kappa coefficient of SenAudi Kit Affected hand score by observer-1 and observer-2:

	A1	A2	
A1	1		
A2	0.991256	1	positive
	High		

* Based on the data analysis the present study shows that there is good correlation coefficient in between two tests (SenAudi Kit and STI test). As kappa coefficient of unaffected and in SenAudi Kit score is only fair or good score, and affected hand score is excellent, and in STI test the kappa coefficient of unaffected hand and affected hand score is excellent. And the percentage disagreement was seen as relative position and relative concentration both has shown positive and high scores which shows there is good correlation coefficient in between the two tests this shows that there is high reliability and validity of SenAudi Kit in assessing sensory functions in post-stroke patients.

Discussion:

In a study about 69% of stroke participants have loss of sensory function in the more affected hand, and 44% in the less affected hand and 20% in both hands according to STI test (15).

Assessing the sensory function include many assessment tools like fugl-meyer assessment of sensorimotor recovery after stroke which is being used from long time in researches, and as assessment tool in clinical settings, etc. it is a passive sensory function assessment tool and the STI test (shape and texture identification test) is having high test-retest reliability in assessing sensory function, which is an active assessment of sensory function as patient actively touches the textures and shapes to identify.

We have created a new sensory assessment tool namely SenAudi Kit which is also used as treatment tool for sensation impaired patients for upper limb / used in sensory integration therapy.

The aim of the study is to find the efficacy of the SenAudi Kit in post-stroke patients. In this study we have compared SenAudi Kit with STI test and observing the correlation in between the two tests.

According to the result of the study we have find out that there is good correlation in between the two tests and there is high validity and reliability for the SenAudi Kit in assessing sensory functions of post-stroke patients. The mean of SenAudi kit score of unaffected hand by observer-1 is 58.866, by observer-2 is 58.1, mean of affected hand score of SenAudi Kit by observer-1 is 52.933, by observer-2 is 53.466 . mean of STI test score of unaffected hand by observer-1 is 5.133, by observer-2 is 5.4, mean of affected hand score of STI test by observer-1 is 3.5 and observer-2 is 3.9

Based on kappa coefficient for the total sum score of SenAudi Kit unaffected hand by observer-2 (UA2) is 0.72 which is a fair or good score, and for affected hand (A2) is 0.99 which is excellent score according to the interpretation of strength of kappa coefficient. The observer-2 scores of kappa coefficient of both the unaffected and affected hands are showing positive relative concentration which means that the participants have more centred score by the second observer, and score high relative position which means the participants have higher scores on the second test occasion than on the first.

Based on kappa coefficient for the total sum score of STI test unaffected hand by observer-2 (UAO2) is 0.81 which is excellent score, and for affected hand (O2A) is 0.933 which is excellent score according to the interpretation of strength of kappa coefficient. The observer-2 of kappa coefficient of both the unaffected and affected hands are showing positive relative concentration which means that the participants have more centred score by the second observer and score high relative position which means the participants have higher scores on the second test occasion than on the first.

So both the SenAudi Kit score and STI test score is showing good/excellent results as they are having strong high and positive values of kappa coefficient which is used to find the correlation coefficient in between the two tests, which is a proven that the SenAudi Kit is having high validity and reliability in assessing the sensory function of post-stroke patients.

There is no standard assessment tool to assess the sensory deficits in patients of different conditions, especially active touch. Assessment tools like Fugl-meyer sensory function assessment tool is a passive touch assessment, patients participation is less and STI (shape and Texture Identification test) is active touch assessment tool with two subtest the subtest one which is identification of textures they have used three raised dots of different sizes in daily life there is less use of identification of raised dots, which doesn't seem practical. And subtest two identification of shapes they have used a circle, a four cornered shape (square) and a six cornered shape (hexagon) they did not follow a order while putting them in shape identification. In SenAudi Kit we have followed all measure like in texture identification we have taken the real textures of different rough and smooth types which patients use in daily life, and in shape identification we have followed order of three cornered shape, four cornered then six cornered but did not jumped direct to six cornered after four cornered shape. This will give a clear idea of patient identification of shape and it won't affect patients score during assessment. SenAudi Kit is a special tool which is also used in treatment of sensory deficits of any condition.

Conclusion:

We conclude that with SenAudi Kit we can assess active touch of the post-stroke patients as it is proved that there is good correlation coefficient in between the two tests, in kappa coefficient the second observer scores in comparison to first observer are showing high relative position and positive relative concentration. This shows that the SenAudi Kit has good reliability and Validity in assessing sensory functions of post-stroke patients.

Conflict of Interest: None
Source of Funding: None

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