USEFULNESS OF ULTRASOUND ASSESSMENT OF FASCICULATIONS IN NEUROLOGICAL DISEASE

Dissertation submitted to

THE TAMILNADU DR.MGR MEDICAL UNIVERSITY

in partial fulfillment of the requirements

for the award of the degree of

DM (NEUROLOGY) – BRANCH -1

MADRAS MEDICAL COLLEGE

THE TAMILNADU DR.MGR MEDICAL UNIVERSITY

CHENNAI

AUGUST 2014

CERTIFICATE

This is to certify that the dissertation entitled **USEFULNESS OF ULTRASOUND ASSESSMENT OF FASCICULATIONS IN NEUROLOGICAL DISEASE** is a bonafide record of work done by **DR.J.MANICKAVASAGAM** in the Institute of Neurology, Rajiv Gandhi Government General Hospital & **MADRAS MEDICAL COLLEGE, CHENNAI** in partial fulfillment of the Tamilnadu Dr.MGR Medical University rules and regulations for the award of **D.M. (NEUROLOGY)** degree under my direct guidance and supervision during the academic year **2011-2014**.

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DECLARATION

I solemnly declare that this dissertation titled **"USEFULNESS OF ULTRASOUND ASSESSMENT OF FASCICULATIONS IN NEUROLOGICAL DISEASE"** is done by me in the Institute of Neurology, Madras Medical College & Rajiv Gandhi Government General Hospital, Chennai under the guidance and supervision of **Prof. Dr. R.LAKSHMI NARASIMHAN, MD., DipNB., D.M., DipNB.,** Professor of Neurology, Institute of Neurology, Madras Medical College & Rajiv Gandhi Government General Hospital, Chennai. This dissertation is submitted to the Tamil Nadu Dr.MGR Medical University, Chennai in partial fulfillment of the university requirements for the award of the degree of D.M. Neurology.

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ACKNOWLEDGEMENT

It gives me great pleasure to acknowledge all those who guided, encouraged and supported me in the successful completion of my dissertation.

First and foremost, I express my gratitude to, the **Dean Dr. R. VIMALA, MD.,** for having permitted me to carry out this dissertation work at Rajiv Gandhi Government General Hospital, Madras Medical College, Chennai.

I am extremely thankful to **Prof. Dr. K. MAHESHWAR, M.ch.** Professor of Neurosurgery, Head of the department, Institute of Neurology, Rajiv Gandhi Government General Hospital, Chennai for his constant encouragement, valuable guidance and support.

I express my deep sense of gratitude and sincere thanks to our respected and beloved Chief **Prof. Dr. R.LAKSHMI NARASIMHAN, MD., DipNB., D.M., DipNB., Professor of Neurology,** Institute of Neurology, Rajiv Gandhi Government General Hospital, Chennai for his valuable suggestions, constant motivation, kind guidance and moral support without which this study would not have been possible.

I express my sincere thanks and gratitude to our Professors **Prof. Dr. K. Bhanu, Dip. NB., D.M.,** P**rof. Dr. G. Sarala, MD., DM., Prof. Dr.M.Balasubramanian,MD.,DM** and **Prof.Dr.V.Kamaraj,MD.,DM.,** for their valuable suggestions and support.

I am extremely thankful to all my **Assistant Professors** for their valuable guidance and support.

I owe my sincere thanks to all the patients and the technical staff who participated in the study for their cooperation which made this study possible.

CONTENTS

ABSTRACT

USEFULNESS OF ULTRASOUND ASSESSMENT OF FASCICULATIONS IN NEUROLOGICAL DISEASE

J.MANICKAVASAGAM [1],R.LAKSHMI NARASIMHAN[2]

Aim: To study and analyze the fasciculations in multiple sites clinically, by EMG and by ultrasound. Find the usefulness of neuro ultrasound in identifying fasiculations both occult and manifest.

Materials and Methods :

Patients who are admitted with fasciculations with neurological illness in RGGGH. Patients with age group between 18yrs to 70 yrs. Totally 30 patients were examined. The duration of study was between December 2012 to Decmber 2013

Assessment by detailed history, neurological examination by standard proforma and criteria, EMG by standardized protocol (AAN), ultrasound examination of muscle using transducer of 7.5 MHZ for 30 seconds in multiple sites were studied. Correlation of EMG, Ultrasound and clinical examination were done

Results and observation:

In our study of 30 patients EMG was compared with ultrasonography in the detection of fasciculations. The correlation coefficient between EMG and USG was 0.024.High degree of correlation was found between the EMG detection of fasciculations and Ultrasound detection of fasciculations which was statistically significant with a p value of <0.005. USG detected more percent of

fasciculations when compared to EMG. USG is noninvasive and fasciculation can be easily detected.

USG can detect occult fasciculation which is difficult to detect by EMG. Different examination by EMG to search for occult fasciculations is difficult since patient may experience pain and technically difficult. But USG can be judiciously used to detect occult fasciculations.

Conclusion:

Neuromuscular ultrasound is a useful technique in neurology especially in confirmation of fasciculations in both clinical and subclinical. The utility of neuromuscular ultrasound in detecting occult fasciculations enables diagnostic accuracy of anterior horn cell disease.

It is comparable to needle EMG in detecting fasciculations . Neuromuscular ultrasound is a non invasive, painless tool in the evaluation of fasciculations.

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Introduction

INTRODUCTION

Muscle fibers belonging to the same unit undergo contractions which are spontaneous in nature. This phenomenon is known as fasciculations. It is a muscle twitch that occurs due to the spontaneous firing of a single motor unit. They appear on the surface of the muscle as rapid fine, flickering and occasionally vermicular contraction. They are irregular in both the timing as well as location of the muscle. Fasciculations that occur in higher frequency and witnessed in almost all examination indicates the presence of a denervating disease especially those of the anterior horn cells.[1]

Even normal people may have fasciculations, termed benign fasciculations because they have no associated muscle weakness or wasting. [2] The presence of fasciculations along with either weakness or wasting of muscles significantly indicates a lower motor neuron disease. Larger fasciculations are seen in larger muscles because they possess a large motor unit. Fasciculations appear as smaller vermicular movements when they occur on surface of the tongue

Though displacement of joint is rare due to fasciculations, rarely joint movements called polyminimyoclonus occur in fingers. In diseases such as post poliomyelitis syndrome, spinomuscular atrophy and Kennedy disease

larger fasciculations occur because muscle undergoes reinnervation of chronic duration. 70 percent of people have fasciculations which are spontaneous yet benign.[3] Few persons who are diagnosed with benign fasciculation have frequent episodes which are either widespread or focal and sometimes accompanied by cramps.

They have normal findings on clinical examination and EMG. Long term follow up of these patients confirm the fasciculations are benign in nature and their presence does not indicate a predisposition towards MND. LMN disorders have abnormal motor units .this could be proved by the needle EMG. Spontaneous discharge of muscle fibers occur in those muscles that are denervated.hey have sharp positive waves and fibrillation potentials when these are isolated in nature found using EDX they are insufficient to diagnose a disorder with loss of axons

Fasciculations that appear on muscle surfaces are visible in clinical inspection. But those occurring deep within the body of a muscle are recorded using needle EMG. Neuromuscular disorders are diagnosed by using muscle USG fasciculations are dynamic changes that occur in diseased muscle. Contraction s occurs in entire motor units comprising the motor neuron and muscle fibers innervating them.

Larger muscle region are sampled using USG which have high sensitivity towards the detection of fasciculations. EMG has less sensitivity than USG in this regard because the samples are smaller. Needle EMG is a painful and inconvenient procedure while USG is an easy noninvasive and safe procedure without any inconvenience to the subjects

Aim of the Study

AIM

1) To study and analyze the fasciculations in multiple sites clinically, by EMG and by ultrasound

2) Find the usefulness of neuro ultrasound in identifying fasciculations both occult and manifest.

Review of Literature

REVIEW OF LITERATURE

Fasciculations are brief rapid twitch that arises from motor neuron due to hyperexcictability. Even in normal person fasciculations are common more so in diseased persons. They commonly occur in chronic neurogenic disorders and rarely in neuromuscular disorders. The definition of fasciculations is contraction of those muscle fibers belonging to a single motor unit. Common clinical presentation of fasciculations display the following characteristics, the contractions are flickering of rapid and fine nature possessing marked irregularity of their location and timing. They occur on the surface of the muscle .Hyper excitable motor axons are the main source of impulse for them. Fasciculations is not only restricted with patients with lower motor neuron but it is also found in people who are normal.[1] Mere fasciculations do not implicate that the concerned person is affected by disease of lower motor neuron type. Fasciculations when occurring in the tongue surface are different from the muscle surface. In the tongue small motions which appear vermicular indicate fasciculations. Instances of fasciculations in a larger scale occur when the muscle is large.

Mini-polymyoclonus are the joint movements that occur in fingers. In conditions such as Postpolio, Kennedy disease and mainly in disease of chronic nature like spinal muscular atrophy, as a result of the involved musculature subjected to reinnervation extended to a large area.[42]

Disease like radiculopathy, cramp fasciculations syndromes[4] and polyneuropathies, involving the peripheries has fasciculations. But it is more prevalent in those disorders that involve the cells of anterior horn. Other causes are, overdose of anticholinesterase medication, thyrotoxicosis. Difference between the fasciculation potentials that occur in both normal and abnormal conditions cannot be elicited easily; it is considered that normal fasciculations discharge rapidly while fasciculations that occur in motor neuron disease have combined potentials which are derived from many motor units.[5]It may be difficult to differentiate benign fasciculations from those associated with disease. In general, benign fasciculations have faster firing rates and occur in muscles below the knees. Lower motor neuron diseases are strongly indicated whenever neurogenic changes of MUAP and fibrillations are co presented with fasciculations potentials. The muscles are weak and atrophy in cases of LMN disease.

The clinical features of lower motor neuron includes loss of strength of muscle, fasciculations atrophy of muscle, loss of deep tendon reflexes and muscle cramps. Clinically fasciculations are under diagnosed.

Table 1 : Disorders associated with fasciculation potentials

Type of Disease	Examples
No disease	Benign fasciculation syndrome Postexercise
Peripheral nerve hyperexcitability syndrome	Cramp fasciculation syndrome Isaacs syndrome
Neurogenic disorders	Anterior horn cell diseases (eg, ALS, Kennedy disease, spinal muscular atrophy) Peripheral neuropathies, axonal Radiculopathies
Metabolic disorders	Hyperthyroidism
Medications	Anticholinesterase agents

Amyotrophic Lateral sclerosis

ALS is a disorder that affects the brainstem spinal cord by causing cell death and damage of lower motor neurons, and upper motor neurons in the motor cortex [5] Mostly middle-aged and elderly individuals are affected with a mean age at onset of 55 to 60 years, and also rarely younger individuals can also be affected. Increasing age, male sex (male-to-female ratio ≈1.6:1), and genetic susceptibility are the only proven risk factors. Approximately 90% of cases of ALS occur sporadically, but 5 to 10% are familial, usually with an autosomal dominant mode of inheritance.

World federation of neurology has classified ALS in to many types[6].ALS has many types like, flail leg syndrome, primary lateral sclerosis, progressive bulbar palsy, progressive muscular atrophy and ALS plus.

The clinical criteria divide candidates into those with definite, probable, lab- supported probable, possible, and based on a careful history and examination of four regions of the neuraxis: bulbar, cervical, thoracic, and lumbosacral.

Table 2 : Clinical features of the motor neuron disorders

	Onset	**Bulbar Involvement**	**Fasciculations**	**Lower Motor Neuron Features**	**Upper Motor Neuron Features**
ALS	Asymmetric and focal	Prominent	Prominent	Prominent	Prominent
PMA	Asymmetric and focal	Less prominent	Prominent	Prominent	Absent
PLS	Symmetrically usually in lower limbs	Prominent in later stages	None	Absent	Prominent
SMA	Symmetrically in proximal limbs	Less prominent	Variable	Prominent	Absent

Table 3 : Diagnostic Criteria for the Clinical Diagnosis of Amyotrophic Lateral Sclerosis

Definite ALS	UMN and LMN signs in at least 3 regions (bulbar and 2 spinal regions or 3 spinal regions without bulbar)
Probable ALS	UMN and LMN signs in 2 regions, with some UMN signs rostral to LMN signs
Probable ALS, lab-supported	UMN and LMN signs in 1 region, with UMN signs alone in another region and EMG evidence of LMN involvement in at least 2 limbs
Possible ALS	UMN and LMN signs in 1 region; or UMN signs alone in 2 or more regions; or LMN signs are rostral to UMN signs
Familial ALS, lab-supported	Otherwise unexplained UMN or LMN signs in at least 1 region, with SOD1 gene mutation in the proband or a positive family history of family member with a disease-causing SOD1 gene mutation

If LMN signs and UMN signs are present in 3 or more areas then the diagnosis is definite ALS. The presence of either LMN or UMN findings in 2 regions is called probable ALS .Possible ALS is the term designated to the presence of the either signs in only one region or the presence of only UMN signs in 2 areas. The same term is used even when only 2 LMN signs are seen in 2regions in addition to rostral region. Patients who present with clinically evident possible ALS in addition to EDX showing extensive involvement of LMN. The signs and symptoms of UMN and LMN combined denote ALS.

The frontal motor regions present in the motor strip undergo degeneration along with their axons ranging from corona radiata to lateral cortical spinal tracts of spinal cord including the internal capsule, cerebral peduncle base of pontine and medullary pyramids this leads to the symptoms pertaining to the upper motor neuron such as spasticity, hyperreflexia and weakness.

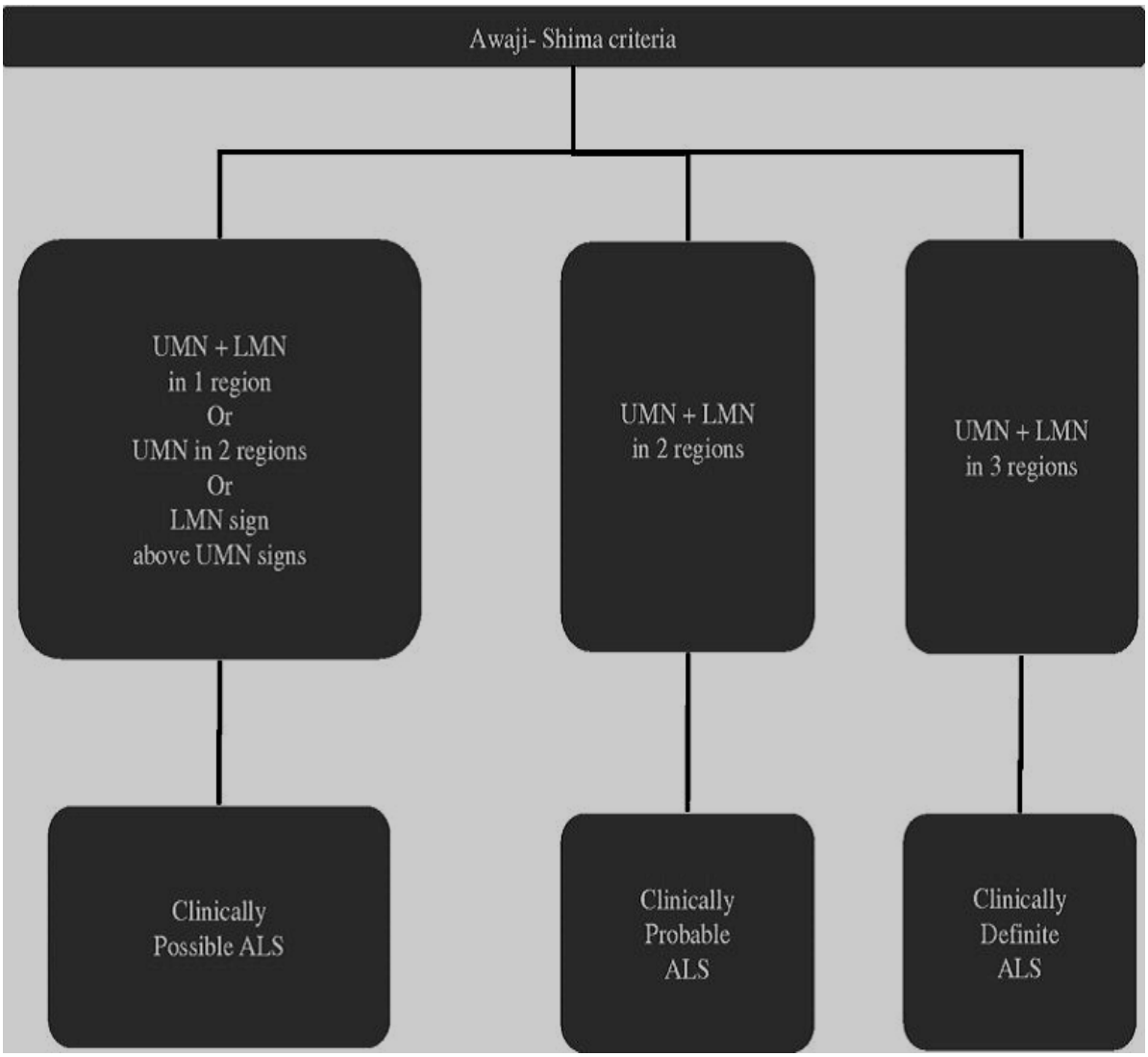
When the lower motor neuron present in the brainstem, spinal cord are affected they produce denervation of muscles supplied by them which leads to LMN features of ALS like muscle weakness, atrophy of muscles, amyotrophy and fasciculations lower motor neuron induced features of muscle weakness, atrophy which ordinarily depress tendon reflexex, instead the deep tendon

reflexes are preserved or paradoxically brisk. This manifestation of hyperreflexia occurs in upper motor neuron dysfunction.

80 percent of ALS presents as asymmetric limb weakness .Bulbar onset, usually manifested as dysarthria or dysphagia, is the next most common pattern (20 percent). However there is marked variations in the presentations and it may present in different sites and segment (cranial, cervical, thoracic, or lumbosacral) of onset, pattern and speed of spread, and the degree of lower motor neuron and upper motor neuron dysfunction.

Awaji algorithm showed acute denervation by the presence of fasciculation.[7] To clarify the EL Escorial criteria Awaji criteria should be applied but increases the diagnostic sensitivity The Awaji algorithm has increased the importance of fasciculation potentials has been emphasized in Awaji criteria which indicates chronic denervation. [17] Carvalho and Swash study showed an increased sensitivity in the diagnosis of bulbar-onset ALS from 38% with revised El Escorial alone to 87% when both sets of criteria were used.[8] A specificity of over 95% when using both sets of criteria together was achieved by another group (carvalho and swash),(doughlass et al). [9] Patients should be followed up to observe the progression of disease

Figure 1


Awaji- Shima criteria
UMN + LMN in 1 region Or UMN in 2 regions Or LMN sign above UMN signs
UMN + LMN in 2 regions
UMN + LMN in 3 regions
Clinically Possible ALS
Clinically Probable ALS
Clinically Definite ALS

Benign Focal amyotrophy

LMN disease which are found in one and only are represented by various terminologies by benign focal amyotrophy, hirayamas disease, juvenile segmental muscular atrophy, brachial monomelic amyotrophy. Causative factors for these diseases are usually not known. The scientist who discovered the disease was Hirayama. He had attributed it to the spinal cord and dura being subjected to compress against the vertebrae which happened when the neck was flexed and extended repeatedly resulting in growth between the vertebral column and the dura.[18]

Though it targets teenagers cases of people over 40 are predominant and males are more affected. Commonly presented as painless weakness along with atrophy in a unilateral upper limb it is also idiopathic and progresses slowly. A few myotomes being limited to the disease is quite common, even though the weakness of muscles may differ in individually. The muscles which are supplied by C7 T1 nerves are unilaterally atrophied when brachioradialis is spared it is called oblique atrophy. [19]

All other muscles have normal stretch reflexes except for those muscles which are supplied by the involved segment. LMN signs include wasting and fasciculations are prominent.UMN signs are absent if they are present ALs should be considered. Initially weakness and atrophy may progress to 2 to 3

yrs but stabilize within 5 yrs.[20-21] In 75 percent of the patient arm is affected and the remaining Calf muscle is affected. Spread may occur to the contra lateral limb in about 20% of cases [10]and rare patients later develop an ALS-like picture.

Postpolio syndrome

Postpolio syndrome is defined as a condition in which persons who suffered from polio years ago, develops symptoms like fatigability of muscles, pain,disturbed sleep,depression,intolerance to cold conditions, difficulty in swallowing and dysarthria.[45] PPMA is another term attributed to the presence of weakened wasted muscles along with the previous symptoms.[11] Only negligible people who survived polio develop this condition. It is defined as new muscle weakness and atrophy which is progressive in nature occurring in the previously affected muscles and rarely in those muscles which were not affected by the acute infection.[46] Even after ten years of recovery the disease course has been stable. [12]Those may include symptoms like fasciculations, cramps and weakness of muscle even stable muscles can be affected muscle weakness and atrophy may be focal and not symmetrical .It is difficult to decide whether they are the remote, static or old and non progressive following. The criteria for post poliomyelitis includes the following[11]

- “A previous episode of poliomyelitis with presence of residual motor neuron loss
- A period of 10 years after the acute onset of polio with functional and neurologic stability
- A gradual onset of new weakness and muscle fatigability which should that persists for at least one year” [11]

Other medical conditions that cause similar symptoms should be excluded. EMG examination shows that those muscles which are clinically affected by acute poliomyelitis have evidence of previous disease[12]. This is characterized by neurogenic MUP changes with or without some acute denervation.[13]

Multifocal Motor Neuropathy

Multifocal motor neuropathy t is an immune mediated neuropathy which is a treatable condition. Multifocal motor neuropathy, also known as multifocal motor neuropathy with conduction block, is defined by the presence of LMN signs that en present in a bi brachial pattern. It is vaguely similar to LMN neuropathy. It targets men around 40 yrs of age and less [14] .Predominantly weakness of distal limbs especially represented by asymmetrical distribution and progressive nature. Two or more peripheral nerve innervates the affected area. It takes many months or years to develop. It does not have not any signs

of UMN type and upper part of the body mainly hands are affected which is characterized by wrist drop, weakness of grip and foot drop.

In the early period there is no loss of muscle bulk. Exercise induced symptoms like muscle cramps, fasciculations are common. Muscles that are very weak inspite of having normal bulk which are innervated by individual nerve are very important for the diagnosis.[15] Ocular nerve, phrenic nerve, hypoglossal nerve and facial nerves may be rarely affected. Respiratory failure is the resultant of phrenic nerve involvement. Tendon reflexes are normally present but rarely depressed. Paraesthesias of very transient and minor nature are seen. Normal functioning of sensory system is seen but rarely a small area of distal limb is affected.

Nerve conduction studies of motor nerves in multifocal motor neuropathy show evidence of conduction block, which represents focal demyelination. Normal Sensory conduction through the same segment of nerve is obtained. Raised titers of GM1 antibodies may be seen in 40 to 70 percent of patients.[14]

MMN is an important diagnosis to consider, as this condition is treatable with intravenous immune globulin [16]

Benign Fasciculation

In 70 percent of people spontaneous fasciculations appear. A smaller number of this group of will have frequent fasciculations that may be focal or widespread and may be accompanied by cramps. Long-term follow-up of patients with frequent fasciculations who have a normal clinical examination and normal EMG suggests that this is a truly benign condition and there is no increased risk for the development of motor neuron disease.[43]

The occurrence of muscle fasciculations in an otherwise healthy person is not regarded as the ominous sign to a progressive lower motor neuron disease (Reed et al). [22]Several reports document the fact that many persons experience fasciculations over a period of years, and the occurrence is without pathological significance. In regard to this change in clinical impression, it is surprising that no definitive investigation has been made to determine the extent to which healthy persons experience fasciculations. This report is an analysis of the occurrence of benign muscle fasciculations in a large group of healthy medical personnel.[23] There is confusion and difference of opinion in the literature concerning the terminology describing benign and pathological fasciculations. When seen with amyotrophic lateral sclerosis and related conditions, fasciculations are considered a true sign of pathology of the motor nuclei of the brain stem or the anterior horn.

Study by Simon NG et al on Fasciculation anxiety syndrome in clinicians to identify the clinical features and pathogenesis of fasciculations. Twenty consecutive clinicians presenting with fasciculations were prospectively assessed with serial clinical and neuro physiological evaluations. Clinicians with fasciculations formed three groups: 70 % of clinicians experienced symptomatic fasciculations and anxiety about the possibility of amyotrophic lateral sclerosis (ALS), termed FASICS; a further 15 % of clinicians experienced fasciculations associated with cramps and consistent with cramp-fasciculation syndrome (CFS).[24]

The final 15 % of clinicians presented with fasciculations associated with sensory symptoms or muscle weakness and were diagnosed with neuropathy (10 %) and ALS (5 %). In FASICS, fasciculations most often involved the lower limbs, without evidence of muscle weakness on clinical examination. Exercise, stress, fatigue and caffeine consumption were identified as common exacerbating factors.

Neurophysiologic studies confirmed normal nerve conduction studies and the presence of simple fasciculations, without acute denervation or neurogenic motor unit change.. In conclusion two main points are inferred a disorder that occurs among doctors who are been screened for fasciculations.

The diagnostic features of FASICS is delineated from the pathological fasciculations

Cervical radiculomyelopathy

Cervical spondylosis with nerve root compression can cause the combination of lower motor neuron signs at the level of abnormality with upper motor neuron signs below it.[44] This condition often includes radicular or distal sensory abnormalities and sphincter dysfunction, but these features may be absent. Cervical MRI establishes the diagnosis. Lower motor neuron findings including fasciculations, weakness, atrophy, and suppressed reflexes in a myotomal distribution in the arms or hands. The C5-7 myotomes are most often affected.

Hyperthyroidism

It is an endocrine disorder characterized by weight loss, palpitation and intolerance to heat. In a thyroid hormone profile there would be an increased level of the thyroxine. Usually it is caused by graves' disease but multiple conditions like excess secretion of thyroid hormone, multinodular goiter , thyroiditis and toxic nodule account for hyperthyroidism .Fasciculations are less commonly seen in hyperthyroidism.[47]

EMG

In a neurogenic disease denervation of the affected muscle fibres occur. When the action potential of the dennervated muscle is measured, we find lesser motor units with a higher rate of firing. This is due to the compensatory effect of the remaining motor unit. Whenever there is denervation active reinnervation occurs. When the new motor units of the developing nerve fires it takes a long time for conduction because they have slow conduction velocities.[25-26]

Due to the combination of both the above factors motor unit action potential is reconfigured and becomes polyphasic and irregular. During chronic innervations more muscle fibres are supplied by few motor units creating an action potential of increased duration and amplitude. The motor unit action potential in a chronic neurogenic condition is broad, high in amplitude and polyphasic. Motor unit number estimation is used in estimating the functioning motor unit .[27-28]

Spontaneous activity as mentioned, normal muscle is electrically silent at rest. An exception is potentials that occur in the region of the muscle endplate. Other types of spontaneous electrical activity at rest are pathological. The spontaneous activities are end plate potential, positive sharp waves, fibrillations and fasciculations. [48]Fibrillations and positive sharp waves are the

classic denervation potentials and are well known in acute neurogenic diseases or nerve trauma. These potentials usually become evident 10 to 14 days after acute nerve injury, but the further the tested muscle is from the site of nerve injury, the later their time of onset.[49]

Fasciculations are single motor unit potentials that are activated spontaneously. They can look like normal or polyphasic voluntarily activated MUAPs, but fire irregularly, and may or may not be voluntarily activated. Fasciculation potentials may be a normal finding, in which case they are considered benign, but are frequently seen in pathologic conditions.[50]

Neuromuscular Ultrasound

Myosonography is a technique where the peripheral nerves and muscles are imaged by using higher resolution ultrasound. Its use was first described in the early 1980s in patients with muscular dystrophy, but since then it has been used to improve diagnostic capabilities in focal neuropathies, inherited neuropathies, inflammatory muscle diseases, and autoimmune mediated neuropathies. Heckmatt introduced muscle ultrasound in paedatrics.[34] Ultrasound in real time mode is used to view muscles and peripheral nerves. Various studies in neuromuscular ultrasound in ALS have been done. Misawa et al have studied the fasciculation potentials in ALS patients which has increased the diagnosis when combined with EMG.[38] Arts etal and Lee cd etal

have also studied the fasciculation potentials using neuromuscular ultrasound in patients with ALS.[38]

Table 4 : Neuromuscular ultrasound studies in ALS

Year	Author	Was Extremity Muscle Atrophy Present?	Were Fasciculations Assessed?	Other Assessments
2011	Misawa S et al.[7]	Not studied	Yes; US was more sensitive than exam and EMG	None
2011	Arts IM et al.[5]	Yes; muscle size declined over time	Yes	Muscle EI increased over time
2011	Arts IM et al.[6]	Yes; muscle size declined over time	Yes	Muscle EI increased over time
2010	Lee CD et al.[4]	Yes; muscle size declined over time	Yes	Muscle EI without change
2010	Tamburrini et al.[3]	Not studied	No	Swallowing evaluated
2008	Arts IM et al.[2]	Yes	Yes	Muscle EI increased at baseline
2007	Yoshioka Y et al.[1]	Not studied	No	Diaphragm paralysis noted

Neuromuscular ultrasound involves the use of high-resolution ultrasound to image peripheral nerves and muscles, which can assist in the diagnosis of a variety of neuromuscular diseases.

In general, diseased muscle has increased echogenicity and increased homogeneity of echo texture, and some diseases result in muscle atrophy with others showing edema and hyper vascularity. Diseased nerves often enlarge, are hypo echoic, and may have increased vascularity. In addition to providing information about muscle and nerve anatomy and pathophysiology, neuromuscular ultrasound is also a promising technique because it is painless, does not use radiation, is relatively inexpensive, is readily available, and often can be performed rapidly. While it has been used to assess many conditions, neuromuscular ultrasound has been studied only minimally in the evaluation of ALS.[41]

In skeletal muscles ultrasound can demonstrate fasciculations and very rarely fibrillations. So this shows it to be very sensitive in finding out fasciculations even in deep seated muscles. Other mode to detect fasciculation is EMG and clinical inspection .Studies shows that ultra sonogram has more sensitivity than EMG or clinical examination for the detection of fasciculations{walker etal}.[29]Ultrasound can be used to assess the wide area of muscles with resolution up to 0.1mm [30](cosgrove etal)

Value of fasciculations in determining the prognosis of ALS [mateen et al] study fasciculation frequency of a muscle was measured using clinical inspection and by surface EMG.[35] In this 24 patients of ALS was selected they were evaluated to note the effects of weakness of limbs ,atrophy ,duration of the disease and the physical activity of the patient. It revealed that as the number of fasciculations increased the weakness of the limbs also increased ,it was also dependent on whether the patient was physically active was increased. However fasciculation frequency was not concurrent to the duration. This was also not dependent on the severity of neither the limb weakness nor the degree of atrophy of the limb. So there is no prognostic importance of fasciculation frequency. Detection of fasciculation is only a diagnostic tool and not a prognostic one.

Muscle fasciculation in a healthy population (Dwayne et al) study reports that two decades ago the mere presence of fasciculation in the muscles of an otherwise healthy person was considered as a sign which might lead to progression of MND.[22] Not all fasciculations are pathogenic. The role of detection of fasciculations in a normal person was not thoroughly investigated. There are no particular criteria's for differentiating benign and pathological fasciculations. [51]Fasciculations seen in ALS and related conditions are considered as pathological, with the motor nuclei of the brain are the anterior

horn cells being affected. Whereas those fasciculations that occur in a normal individual are termed benign. Three longitudinal studies have examined muscle thickness, as measured by ultrasound, in individuals with ALS, and all have demonstrated a small but statistically significant decrease in muscle thickness over several months.[34]

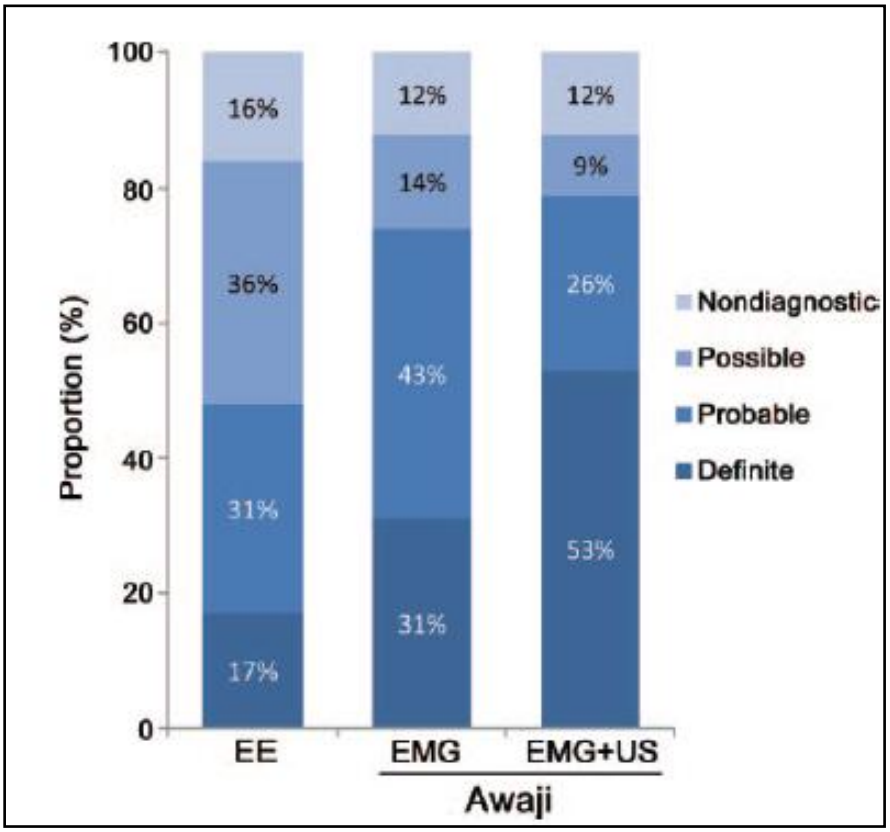
In a 2008 review of prospective case-control studies, the sensitivities of visual evaluation of muscle echo intensity for the detection of a neuromuscular disorder in children ranged from 67 to 81 percent, and corresponding specificities ranged from 84 to 92 percent. [36] Among studies using methods that quantified muscle echo intensity, the sensitivities were higher and ranged from 87 to 92 percent. Thus, quantitative techniques may yield further improvements in the diagnostic utility of ultrasound.[33-36]

Ultrasound allows specific aspects of fasciculations to be studied, such as twitch contraction time, contraction and relaxation durations, cross sectional area involved by the twitch, and recurrence and serial study, but these features are largely of research significance

A variety of other aspects of altered dynamic function of muscle are amenable to study by ultrasound, such as changes in angles of pen nation in disorders of muscle shortening, loss of contractile thickening in myopathic or

neurogenic weakness, slowed or increased relaxation times in thyroid disease, or myotonic or cramp, but such studies have largely gone unperformed. Neuromuscular ultrasound is a technique that can be considered to improve diagnostic accuracy in the evaluation of individuals suspected to have ALS. If used, based on the current state of knowledge, the highest yield parameters would be to assess nerve cross-sectional area and muscle to detect fasciculation.[37]

Figure 2 : Diagnostic category of revised EI Escorial Criteria (EE) and Awaji criteria using only EMG or a combination of EMG and ultrasound (US)



This shows that the proportion of people in the probable and definite category by EL Escorial (EE) criteria was 48% and this increased to 79% when the Awaji criteria along with the use of EMG and Ultrasound was applied (Figure 2)

The diagnosis of amyotrophic lateral sclerosis (ALS) is frequently challenging, because lower motor neuron involvement is usually focal in onset. An early diagnosis is clinically important, particularly in a future clinical trial; the candidates should be diagnosed precisely in the early stage of the disease. However, conventional revised El Escorial criteria1 show good specificity but limited sensitivity.

To improve the sensitivity of diagnostic criteria, an international consensus meeting was held in Awaji-shima, Japan, and the best use and interpretation of electrophysiologic data in ALS were debated. One of the significant differences between the revised El Escorial and Awaji criteria is that in the latter, fasciculations were reintroduced as evidence of acute denervation in the presence of chronic neurogenic changes on needle EMG equivalent to fibrillations and positive sharp waves. Fasciculations are present so regularly in ALS that their absence raises diagnostic doubts.[38]

Materials and Methods

MATERIALS AND METHODS

Study Centre:

. Institute of Neurology, Madras Medical College and Rajiv Government General Hospital, Chennai

Study design:

. Cross sectional study

Study period:

December 2012 to December 2013

Study Sample:

Thirty (30) patients with history of fasciculations admitted in Neurology department, Rajiv Gandhi Government General hospital, Chennai

Inclusion criteria:

Patients admitted with history of fasciculations ,on follow up and treatment for the neurological diseases

Exclusion criteria:

Patients with severe disability and drug induced fasciculations were excluded.

Assessment by detailed history, neurological examination by standard proforma and criteria, EMG by standardized protocol (AAN), ultrasound examination of muscle using transducer of 7.5 MHZ for 30 seconds in multiple sites were studied.

Correlation of clinical examination, EMG and Ultrasound was done

Clinical Evaluation:

Clinical evaluations of all the patients were done with a proforma (see annexure) that includes the following demographic profile, duration of illness, progression of the disease, proximal ,distal and bulbar involvement, visual inspection of fasciculations in relaxed muscle

The following investigations were done, random blood sugar, measurement of blood pressure, thyroid profile,MRI spine ,nerve conduction study.

Electromyography (EMG):

The EMG evaluation to determine the electrical function of individual muscle motor unit potentials at rest and during muscle contraction was done for all patients. It is performed by inserting a recording needle electrode into the belly of a muscle. The needle tip is the recording electrode and the needle shaft is the reference electrode in a concentric needle.

Electrical activity from muscle fibers is recorded and amplified to appear on monitor as a tracing of voltages versus time with accompanying sound. Spontaneous activity, Motor unit action potentials (MUAPS), Interference pattern were observed and interpreted as normal, myopathic or neurogenic patterns.

Interpretation:

Normal-no spontaneous activity, MUAPs with 3-4 phases,amplitude of 0.5 to 2 mV, duration of 5-15ms and a normal interference pattern.

Neurogenic: spontaneous activity-present (positive sharp waves, fibrillation potentials, fasciculations, MUAPs-large amplitude, polyphasic, longer duration, interference pattern-incomplete.

Myopathic: no spontaneous activity (except in myotonic dystrophy, where myotonic discharges are seen), MUAPs-normal to low amplitude, polyphasic, shorter duration, interference pattern-complete with early recruitment.

The resting potentials in more than seven sites were explored for at least 30 seconds in relaxed muscles to determine whether they were fasciculations were present or not. Fasciculations were defined as motor unit potentials, which fired in an irregular pattern.

Ultrasound assessment

Ultrasound examination of muscle using transducer of 7.5 MHZ for 30 seconds in multiple sites were studied. Fasciculations were observed in resting muscle.

Patients were placed in supine and prone position. USG was done in the transverse plane with a standard transducer location corresponding to the muscle belly

Data Analysis:

All the data were tabulated in Microsoft XL sheet, followed by analysis using SPSS software

Results and Analysis

RESULTS AND ANALYSIS

Figure 3 : AGE DISTRIBUTION

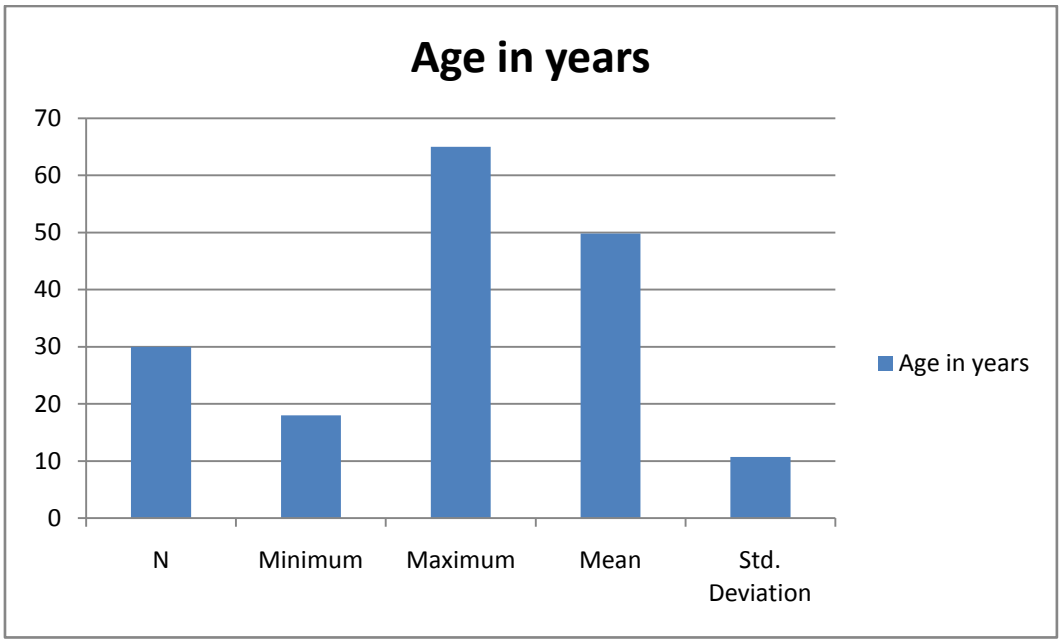


Table 5

	N	Minimum	Maximum	Mean	Std. Deviation
Age in years	30	18	65	49.83	10.706

In our study of 30 patients with fasciculations the minimum age was 18 and the maximum age was 65 yrs

Figure 4 : SEX DISTRIBUTION

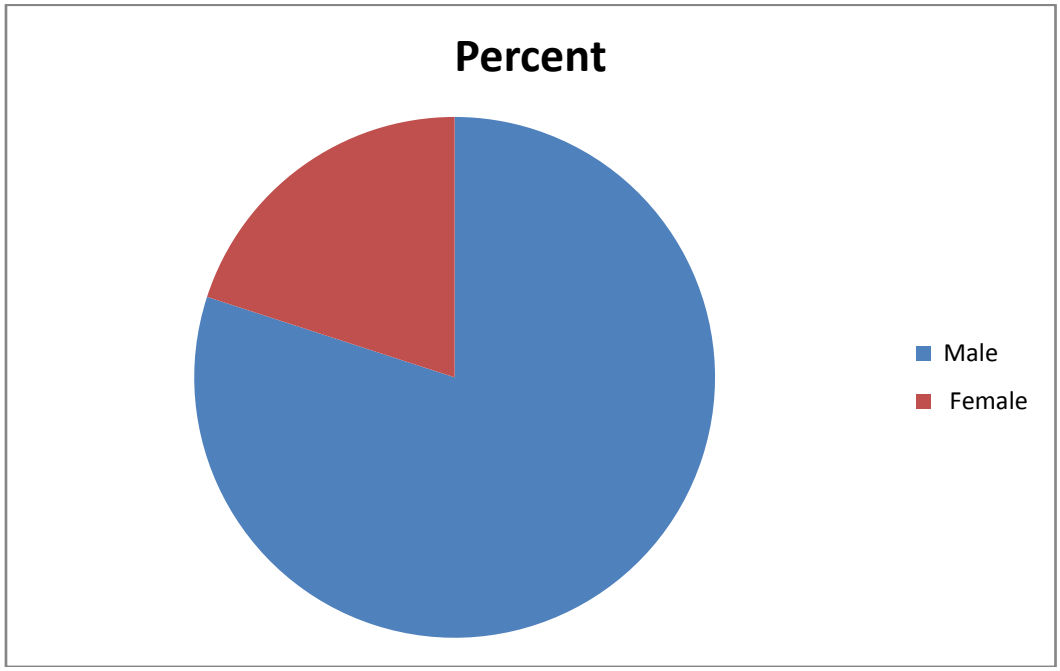
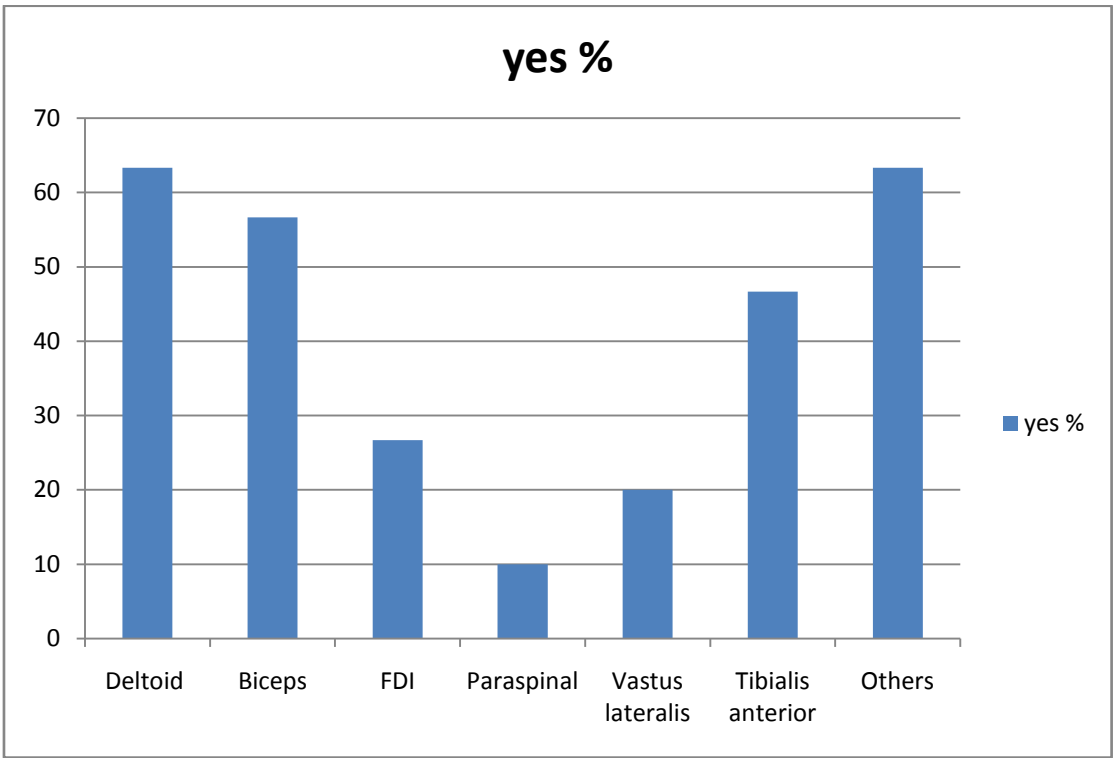


Table 6

Sex	Frequency	Percent
Male	24	80.0
Female	6	20.0
Total	30	100.0

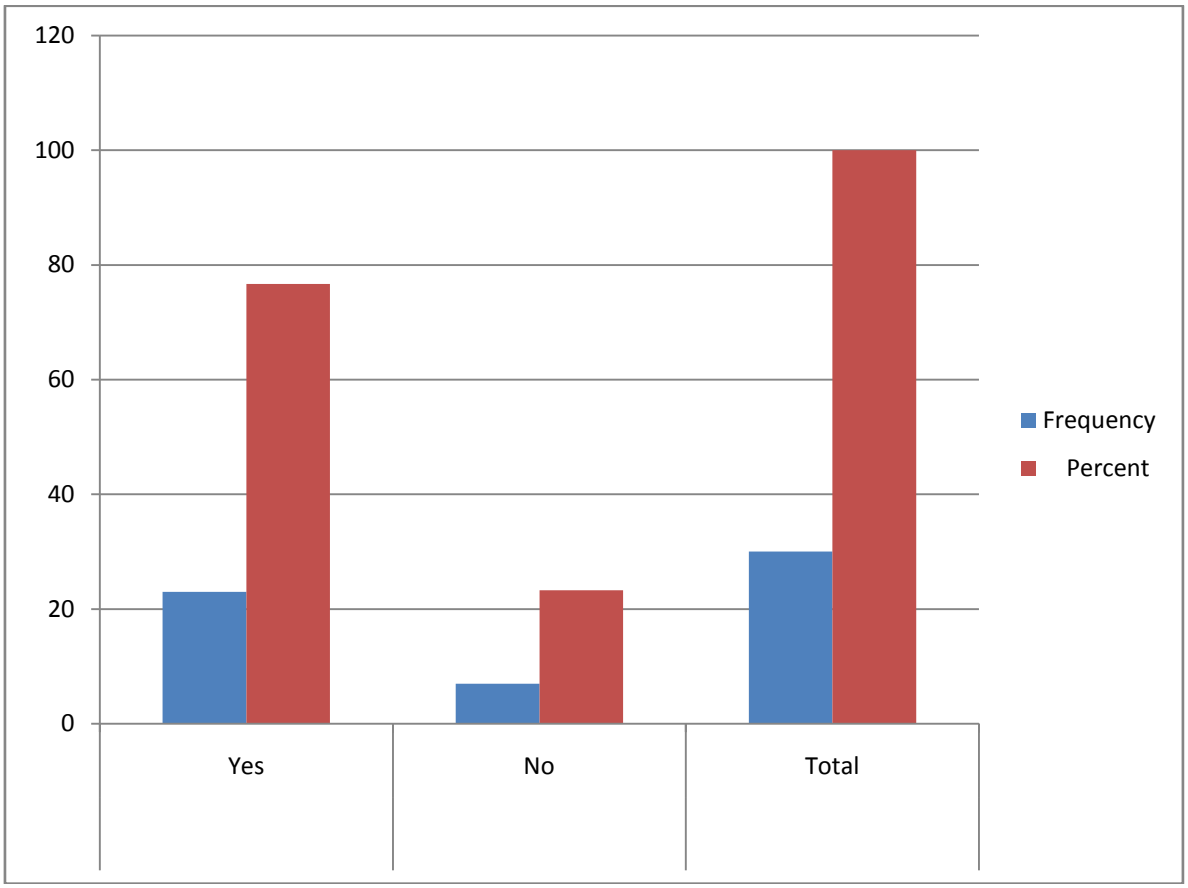
In this study of 30 patients male population was predominantly affected with 80% and frequency of 20 whereas females were remaining 20% and frequency of 10.

Figure 5 : FASCICULATIONS OBSERVED BY MYOSONOGRAM



Fasciculations present in different muscles Fasciculations was predominantly seen in Deltoid muscle followed by biceps. It was least seen in first dorsal interossei. Other areas were fasciculations observed are chest wall and abdomen

Figure 6 : WASTING OF MUSCLES



Wasting of muscles were noted in 76 percent of the muscles examined. Wasting was predominantly note in distal muscles of both upper and lower limbs. Fasciculations was frequently noted in wasted muscles

Figure 7 : FREQUENCY OF DISEASES ASSOCIATED WITH FASCICULATION

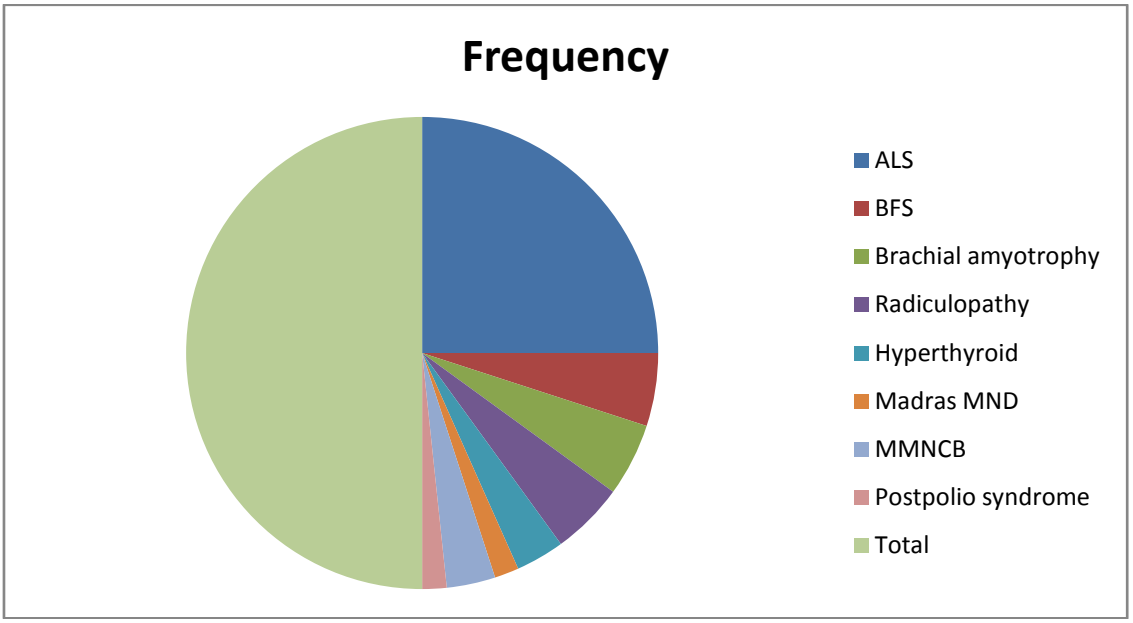


Table 7

Diagnosis	Frequency	Percent
ALS	15	50.0
BFS	3	10.0
Brachial amyotrophy	3	10.0
Radiculopathy	3	10.0
Hyperthyroid	2	6.7
Madras MND	1	3.3
MMNCB	2	6.7
Postpolio syndrome	1	3.3
Total	30	100.0

In our study 30 patients were examined with fasciculations. Amyotrophic lateral sclerosis patient presented with fasciculations commonly followed by benign fasciculation syndrome and brachial amyotrophy

Figure 8 : PROGRESSION OF THE DISEASE

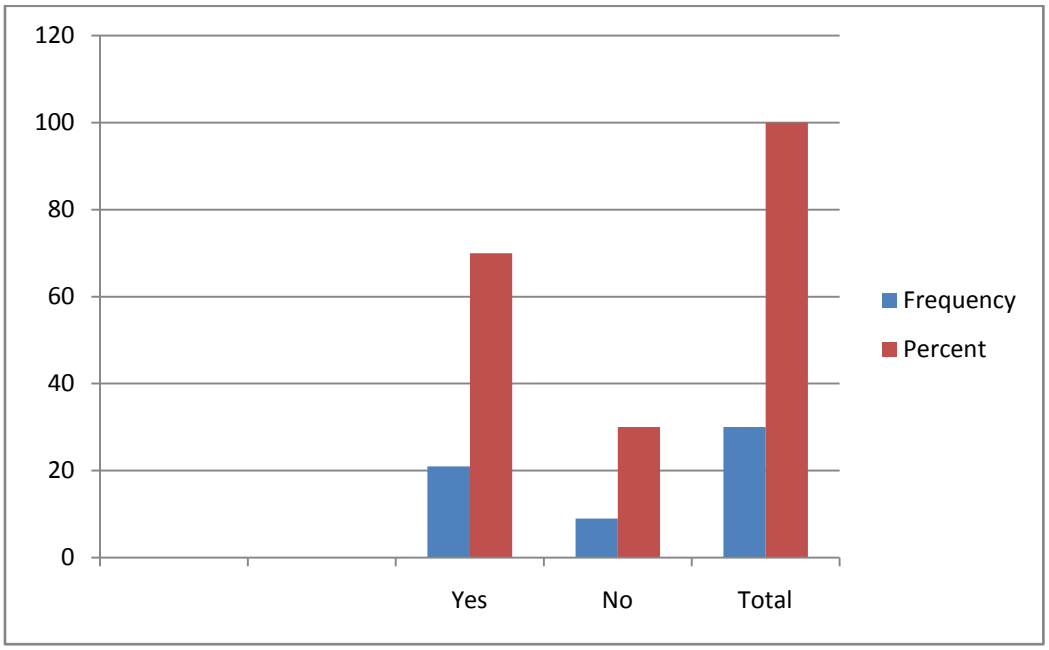


Table 8

Progression	Frequency	Percent
Yes	21	70.0
No	9	30.0
Total	30	100.0

Out of the 30 patients studied 70 percent has progression of the disease whereas 30 percent disease was static

Figure 9 : PROXIMAL MUSCLE WASTING

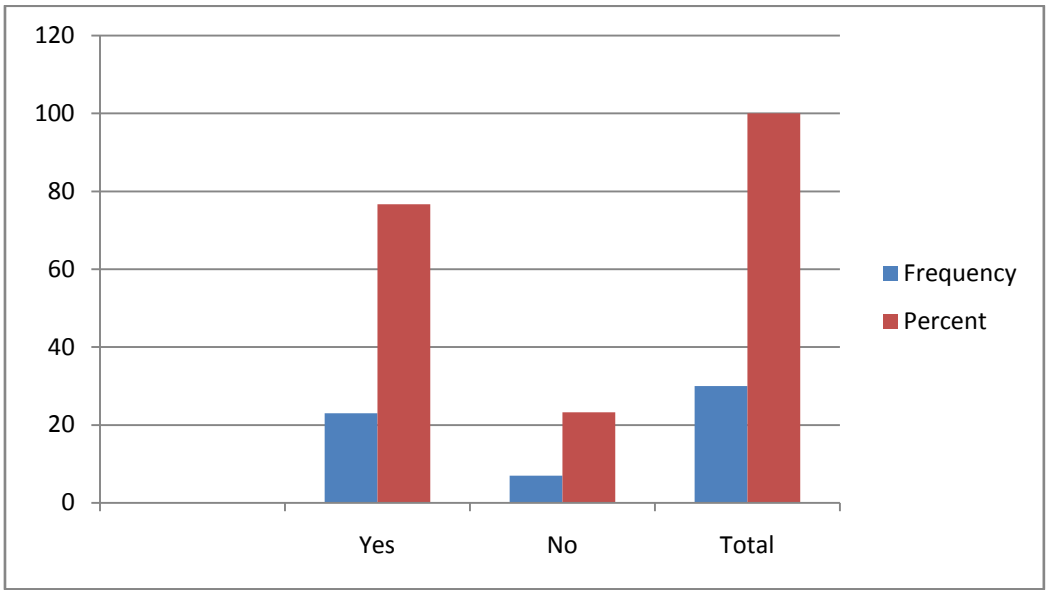


Table 9

Proximal	Frequency	Percent
Yes	23	76.7
No	7	23.3
Total	30	100.0

In our study of 30 patients with fasciculations 76 percent of them had proximal wasting.

Figure 10 : DISTAL MUSCLE WASTING

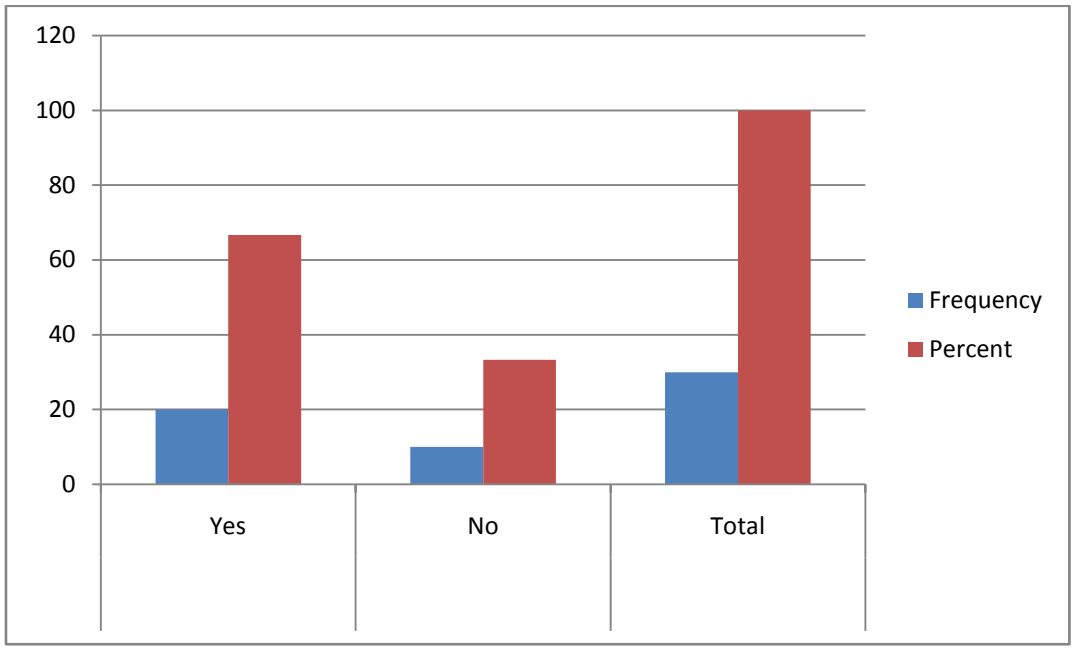


Table 10

DISTAL	Frequency	Percent
Yes	20	66.7
No	10	33.3
Total	30	100.0

Distal muscle wasting was present in 66 percent out of the 30 patients in our study group

Table 11 : CORRELATION COEFFICIENT BETWEEN CLINICAL AND EMG

Variables	Correlation Co efficient	P value
Clinical and EMG	0.413	**0.023***

Note * denotes significant at 5 % level

Clinical and EMG	**Pearson Correlation**	**.413(*)**
	Sig. (2-tailed)	.023
	N	30

* Correlation is significant at the 0.05 level (2-tailed).

A high degree of correlation was found between the clinical diagnosis of fasciculations and EMG detection of fasciculations which was statistically significant with a p value of <0.005.EMG detects more number of fasciculations compared to clinical examination.

Table 12 : CORRELATION CO EFFICIENT BETWEEN CLINICAL AND USG

Variables	Correlation Co efficient	P value
Clinical and EMG	0.396	0.031*

Note * denotes significant at 5 % level

Clinical and EMG	**Pearson Correlation**	.396(*)
	Sig. (2-tailed)	.031
	N	30

* Correlation is significant at the 0.05 level (2-tailed).

A high degree of correlation was found between the clinical diagnosis of fasciculations and Ultrasound detection of fasciculations which was statistically significant with a p value of <0.005.

Table 13 : CORRELATION CO EFFICIENT BETWEEN EMG AND USG

Variables	Correlation Co efficient	P value
EMG and Ultrasound	0.413	0.024*

Note * denotes significant at 5 % level

EMG and USG	**Pearson Correlation**	**.412(*)**
	Sig. (2-tailed)	.024
	N	30

* Correlation is significant at the 0.05 level (2-tailed).

A high degree of correlation was found between the Electromyography detection of fasciculations and Ultrasound detection of fasciculations which was statistically significant with a p value of <0.005.

Table 14 : COMMON SITES OF FASCICULATIONS

Muscles	Yes		No		P=Value
	Count	%	Count	%	
Deltoid	19	63.33	11	36.67	< 0.001
Biceps	17	56.67	13	43.33	
FDI	8	26.67	22	73.33	
Paraspinal	3	10.00	27	90.00	
Vastus lateralis	6	20.00	24	80.00	
Tibialis anterior	14	46.67	16	53.33	
Others	19	63.33	11	36.67	

Fasciculations were commonly seen in deltoid followed by Biceps muscles. Other areas include chest wall shoulder area and back muscles. Paraspinal area was the least amount of fasciculations detected.

Figure 11 : BULBAR INVOLVEMENT

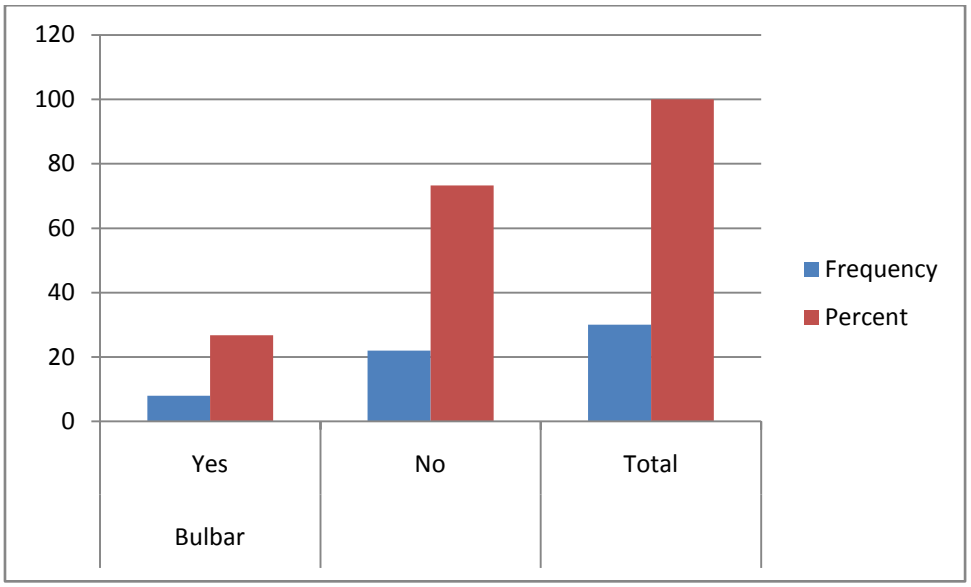


Table 15

Bulbar	Frequency	Percent
Yes	8	26.7
No	22	73.3
Total	30	100

Only 26 percent of the patients had bulbar involvement. AlS patients had bulbar symptoms and was the initial presentation in few patients

Figure 12 : THYROID PROFILE

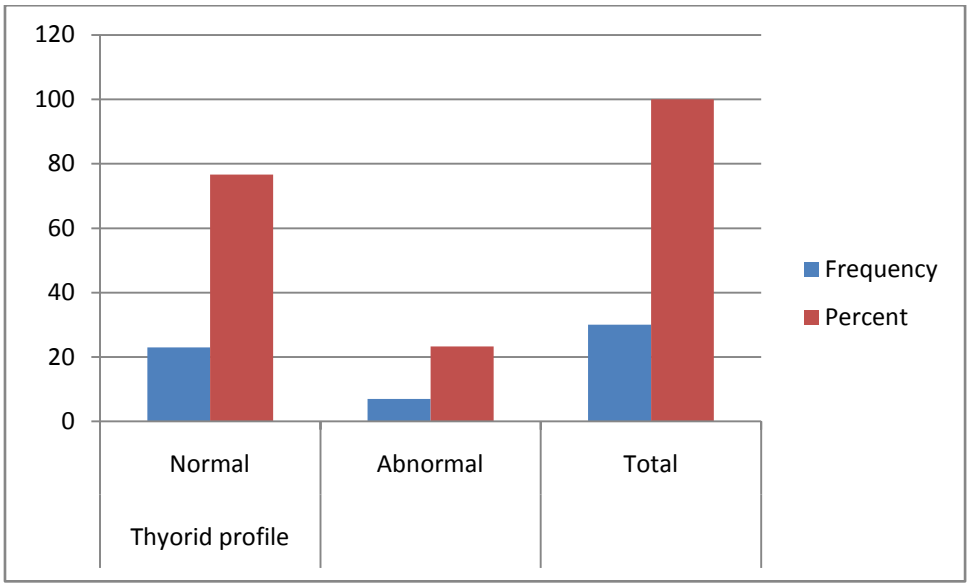


Table 16

Thyroid profile	Frequency	Percent
Normal	23	76.7
Abnormal	7	23.3
Total	30	100.0

All the 30 patients were screened for thyroid profile and abnormalities were found in 23 percent. Three persons with hyperthyroid had fasciculations

Figure 13 : DURATION OF DISEASE

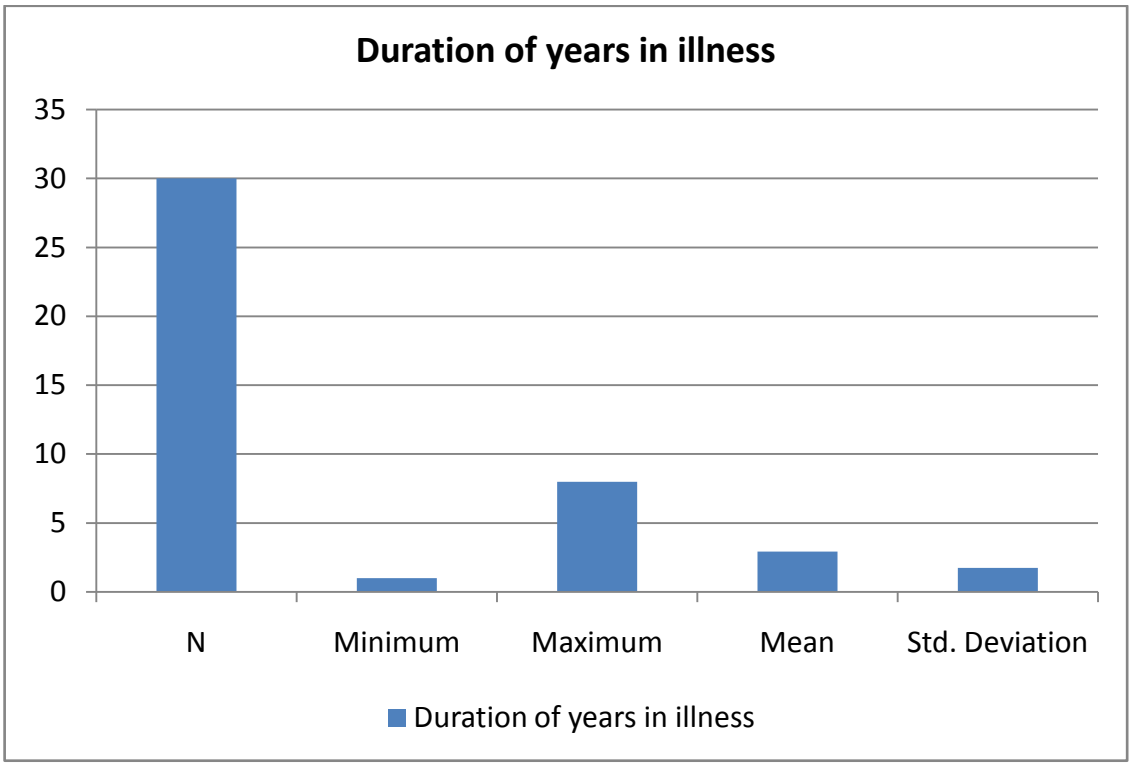


Table 17 : Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Duration of years in illness	30	1.0	8.0	2.930	1.7519

The minimum duration of illness in our study of 30 patients was 1 year and the maximum was 8 years

Figure 14 : DIABETES MELLITUS

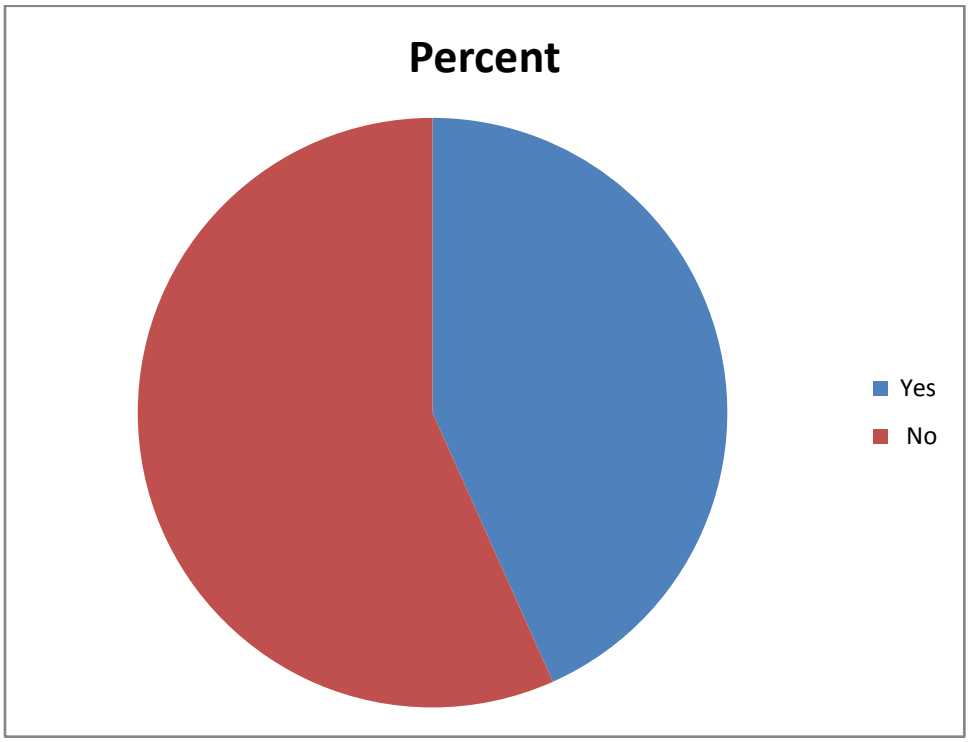


Table 18

Diabetes	Frequency	Percent
Yes	13	43.3
No	17	56.7
Total	30	100.0

Out of the 30 patients 43 percent had diabetes mellitus.

Figure 15 : SYSTEMIC HYPERTENSION

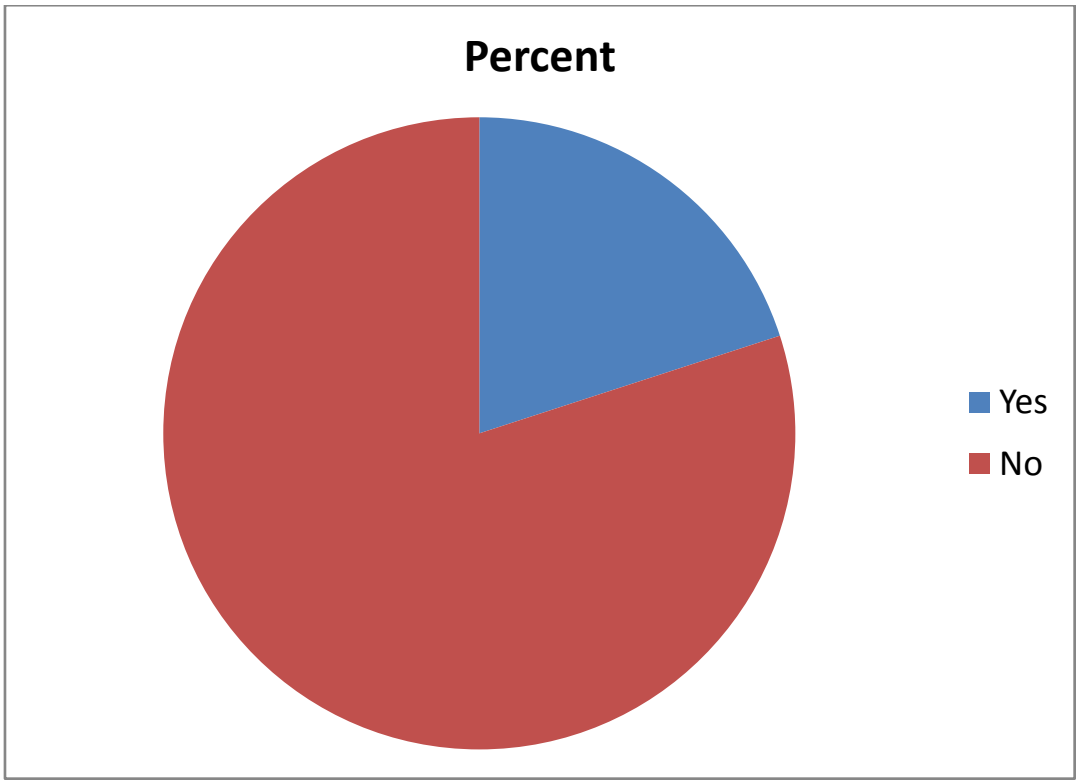


Table 19

SHT	Frequency	Percent
Yes	6	20.0
No	24	80.0
Total	30	100.0

Out of the 30 patients with fasciculations 20 percent had systemic hypertension.

Discussion

DISCUSSION

It may be appropriate to perform the ultrasonographic evaluation first, as it can then be used to guide the electro diagnostic study and perhaps limit the number of electrical stimulations from nerve conduction studies and EMG needle sticks needed. In our study of 30 patients with fasciculations the minimum age was 18 and the maximum age was 65 yrs. In this study of 30 patients male population was predominantly affected with 80% and frequency of 20 whereas females were remaining 20% and frequency of 10. Fasciculations was predominantly seen in Deltoid muscle followed by biceps. It was least seen in first dorsal interossei. Other areas were fasciculations observed are chest wall, shoulder area and back muscles. Para spinal area was the least amount of fasciculations detected.

Wasting of muscles was noted in 76 percent of the muscles examined. Wasting was predominantly note in distal muscles of both upper and lower limbs. Fasciculations was frequently noted in wasted muscles. Amyotrophic lateral Sclerosis patient presented with fasciculations commonly followed by benign fasciculation syndrome and brachial amyotrophy. Least common was postpolio syndrome and MMNCB. 70 percent has progression of the disease whereas 30 percent disease was static.

Out of the 30 patients in our study group76 percent of them had proximal wasting and 66 percent has distal muscle wasting. Only 26 percent of the patients had bulbar involvement. ALS patients had bulbar symptoms and were the initial presentation in few patients.

All the 30 patients were screened for thyroid profile and abnormalities were found in 23 percent. Three persons with hyperthyroid had fasciculations

Comparative study of fasciculations using clinical, EMG and ultrasonographic assessment {reimer et al} showed the effectiveness of clinical inspection, myosonography and electromyography for the detection of fasciculations which are an important clinical entity present in MND .[31]Earlier only EMG and inspection done clinically were used to detect fasciculation but at present myosonography is included with them .The comparative value of these tools of examination shown in this study. Totally 30 people were studied First step all of they were visually screened for fasciculation then EMG and myosonography was done. Fasciculations were examined in seven muscles of all persons by clinical inspection, EMG and myosonography . Fasciculations were detected at 54 sites by clinical examination out of the 210 sites examined for 30 patients. EMG detected 61 sites of fasciculation whereas Ultrasound detected 90 sites of fasciculations. The reliability of EMG and USG is higher than that of clinical inspection. . The coefficient correlation comparing clinical and EMG was 0.023 which was significant P value. The percentage of

detection of fasciculations by EMG was higher than clinically. EMG has a disadvantage of pain,and interpretation by skilled persons who are trained in EMG.[41] The coefficient correlation comparing clinical and ultrasonography was 0.032 which has a significant p value. A high degree of correlation was found between the clinical and USG diagnosis of fasciculations.USG is painless and can be repeatedly used in persons with suspected ALS for follow up[40]

Comparative study involving muscle sonography and EMG (wenzel et al) the prevalence of fasciculations in the 10 muscles of lower extremity were evaluated. 54 patients suffering from a variety of neuromuscular diseases were chosen, while 58 healthy people formed the control group. Screening of each muscles for 10 second by myosonography found fasciculations in 8 muscles of the control group{19%}. 41 people with disease {76%} had fasciculations in 10 muscles. Surface EMG for 10 seconds detected fasciculations in 30 patients[56%] and 5 subjects of [9%] of the control group. In a 20 minute recording time 55 control subjects {95%} and all the patients were found to have fasciculations [33]. But artifacts were common in surface EMG and less in USG .So myosonography was accurate in 79%. Convenience and reliability of muscle USG over surface EMG is proven.

In our study of 30 patients EMG was compared with myosonography in the detection of fasciculations . The correlation coefficient between EMG and

USG was 0.024.High degree of correlation was found between the EMG detection of fasciculations and Ultrasound detection of fasciculations which was statistically significant with a p value of <0.005. USG detected more percent of fasciculations when compared to EMG. USG is noninvasive and fasciculation can be easily detected.

In our study 3 persons had benign fasciculations and USG detected fasciculations. No cause could be found for the benign fasciculations after investigations.

USG can detect occult fasciculation which is difficult to detect by EMG. Different sites examination by EMG to search for occult fasciculations is difficult since patient may experience pain and technically difficult. But USG can be judiciously used to detect occult fasciculations . In our study of 30 patients with history of fasciculations the number of muscles detected by clinically,EMG and myosonography was 54,61 and 90 respectively. So 36 muscles with occult fasciculations were detected by USG. Many fasciculations, detected by either electromyography (EMG) or by ultrasound, are not clinically apparent, as clinical recognition depends on their proximity to the surface of the muscle, the depth below the skin, and the size of the motor unit involved.

Needle EMG shows alteration of serum CPK that interferes with the diagnosis whereas neuromuscular ultrasound is noninvasive and there is non interference with CPK.

Ultrasound may be slightly more sensitive than EMG at detecting fasciculations, probably because it samples a larger muscle region than needle EMG, but it can sometimes be difficult on ultrasound to detect fasciculations in patients who are unable to completely relax

Conclusion

CONCLUSION

1. Neuromuscular ultrasound is a useful technique in neurology especially in confirmation of fasciculations in both clinical and subclinical.

2. The utility of neuromuscular ultrasound in detecting occult fasciculations enables diagnostic accuracy of anterior horn cell disease.

3. It is comparable to needle EMG in detecting fasciculations

4. Needle EMG shows alteration of serum CPK that interferes with the diagnosis whereas neuromuscular ultrasound is noninvasive and there is non interference with CPK.
5. Neuromuscular ultrasound is a non invasive, painless tool in the evaluation of fasciculations.

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Annexures

ABBREVIATIONS

ALS	-	Amyotrophic lateral sclerosis
USG	-	Ultrasonogram
EMG	-	Electromyography
MUAP	-	Motor Unit Action Potentials
UMN	-	Upper Motor Neuron
LMN	-	Lower Motor Neuron
MMN	-	Multifocal Motor Neuropathy
BFS	-	Benign Fasciculation Syndrome
CFS	-	Cramp Fasciculation Syndrome

PROFORMA

Name: Age: Sex: OP / IP :

Address:

History:

Age of onset :
Mode of onset :
Duration of illness :
Progression : Static / Progressive

H/o. Fasciculations : Present / Absent
H/o. Muscle pain : Present / Absent

Weakness:

Symmetrical / Asymmetrical
Proximal / Distal / Both
Limbs : UL / LL / Both
Trunk : Present / Absent
Neck Muscles : Present / Absent
Bulbar involvement : Present / Absent
H/o. Thinning of muscles : Present / Absent
H/o Fasciculations : Present/Absent

Past History:

DM / SHT / IHD / BA / PT / Surgery

Personal History:

Smoking : Present / Absent
Alcohol : Present / Absent

On Examination:

HMF :

Cranial nerves :

Muscle Wasting : Present /Absent

Upper limb : Proximal/Distal
Lower limb : Proximal/Distal

Muscle Fasciculations : Present / Absent

Tongue :

Upper limb :

Lower limb :

Trunk :

Other sites :

Tone : Normal / Hypotonia / Hypertonia

Power:

		Right	Left
Upper limbs	Proximal		
	Distal		
Lower limbs	Proximal		
	Distal		
Hand Grip			

Deep Tendon Reflexes : BJ SJ TJ KJ AJ
Right :
Left :

Superficial reflexes
Corneal
Conjunctival
Abdominal
Plantar

Sensory system

Cerebellum
EPS

INVESTIGATIONS

Complete blood count :

RFT :

LFT :

Thyroid profile :

Serum calcium :

MRI Spine and Brain :

Nerve conduction study :

EMG :

ULTRASOUND

MUSCLE FASCICULATIONS

Deltoid : Present/Absent

Biceps : Present/Absent

First Dorsal interossei : Present/Absent

Paraspinalis : Present/Absent

Vastus lateralis : Present/Absent

Tibialis anterior : Present/Absent

Other sites : Present/Absent

EMG

Deltoid

Biceps

FDI

Paraspinalis

Vastus lateralis

Tibialis anterior

Others

PATIENT CONSENT FORM

Study Details : **Usefulness of ultrasound assessment of fasciculations in neurological disease**

Study Centre : Madras Medical College &
Rajiv Gandhi Government General Hospital, Chennai- 03

Patient may check (✓) these boxes:

I confirm that I have understood the purpose of procedure for the above study. I have the opportunity to ask questions and all my questions and doubts have been answered to my complete satisfaction. ☐

I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving reason, without my legal rights being affected. ☐

I understand that the sponsor of the clinical study, others working on the sponsor's behalf, the ethical committee and the regulatory authorities will not need my permission to look at my health records, both in respect of current study and any future research that may be conducted in relation to it, even if I withdraw from the study I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from this study. ☐

I agree to take part in the above study and to comply with the instructions given during the study and faithfully cooperate with the study team and to immediately inform the study staff if I suffer from any deterioration in my health or well being or any unexpected or unusual symptoms. ☐

I hereby give permission to undergo complete clinical examination and diagnostic tests including hematological, biochemical, microbiological, radiological tests and lumbar puncture procedures, if deemed necessary. ☐

I hereby consent to participate in the study.

Signature/Thumb impression:

Place:

Patient name and address: Date:

Signature/Thumb impression:

Place:

Study investigator's name: Date:

PATIENT INFORMATION SHEET

- We are conducting a study of Usefulness of ultrasound assessment of fasciculations in neurological diseasee in patients attending the Neurology services of Rajiv Gandhi Government General Hospital, Chennai.

- The purpose of the study is to assess the clinical and electrophysiological profile of the patients with Parkinson disease and healthy controls and analyze the correlation between them.

- The privacy of the patients in the research will be maintained throughout the study. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared.

- Taking part in the study is voluntary. You are free to decide whether to participate in this study or to withdraw at any time; your decision will not result in any loss of benefits to which you are otherwise entitled.

- The results of the study may be intimated to you at the end of the study period or during the study if anything is found abnormal which may aid in the management or treatment

Signature of the investigator **Signature of the participant**

Date:

MASTER CHART

S.No	Age in years	Sex	Diagnosis	Duration of years in illness	Progression	PROXIMAL	DISTAL	Wasting	Bulbar	Clincial	EMG	USG	DM	SHT	Thyroid profile	MRI Spine	NCS	Deltoid biceps FDI	biceps	FDI	Paraspinal	Vastus lateralis	Tibialis anterior	Others
1	51	Male	ALS	2	Yes	Yes	Yes	Yes	Yes	3	3	5	Yes	Yes	Normal	Normal	Normal	Yes	Yes	No	No	Yes	Yes	Yes
2	61	Male	ALS	3	Yes	Yes	Yes	Yes	No	2	3	3	No	Yes	Normal	Abnormal	Normal	Yes	Yes	No	No	No	Yes	No
3	18	Male	Madras MND	1.5	Yes	Yes	Yes	Yes	Yes	1	3	3	No	No	Normal	Normal	Normal	Yes	Yes	Yes	No	No	No	No
4	40	Male	Brachial amyotrophy	5	No	Yes	Yes	Yes	No	3	1	3	No	No	Normal	Normal	Normal	Yes	Yes	Yes	No	No	No	No
5	47	Male	BFS	3	No	No	No	No	No	1	1	3	Yes	No	Abnormal	Normal	Normal	No	Yes	No	No	No	Yes	Yes
6	39	Female	Hyperthyroid	3	No	No	No	No	No	1	1	2	Yes	Yes	Abnormal	Normal	Normal	No	No	No	No	No	Yes	Yes
7	47	Male	MMNCB	2.4	Yes	No	Yes	Yes	No	2	2	3	No	No	Normal	Normal	Abnormal	Yes	Yes	Yes	No	No	No	No
8	59	Male	ALS	3	Yes	Yes	Yes	Yes	No	1	2	3	No	No	Normal	Normal	Normal	No	No	Yes	Yes	No	Yes	Yes
9	47	Male	Radiculopathy	1.7	No	Yes	No	Yes	No	0	1	2	Yes	No	Normal	Normal	Abnormal	Yes	No	No	Yes	No	No	No
10	43	Female	ALS	3.6	Yes	Yes	Yes	Yes	Yes	2	3	5	Yes	No	Normal	Normal	Normal	Yes	No	No	No	Yes	Yes	Yes
11	38	Male	Bibrachial amyotrophy	5	No	Yes	No	Yes	No	2	2	3	No	No	Normal	Normal	Normal	Yes	Yes	No	No	No	No	Yes
12	56	Male	cervical radiculopathy	2	Yes	Yes	No	Yes	No	1	1	3	Yes	No	Normal	Abnormal	Abnormal	No	Yes	No	Yes	No	Yes	Yes
13	38	Female	Hyperthyroid	7	No	No	No	No	No	2	1	2	Yes	Yes	Abnormal	Normal	Normal	No	Yes	No	No	No	No	No
14	33	Male	BFS	8	No	No	Yes	No	No	2	2	3	Yes	Yes	Normal	Normal	Normal	Yes	Yes	No	No	No	No	Yes
15	61	Male	ALS	3.2	Yes	Yes	Yes	Yes	Yes	3	4	4	No	No	Abnormal	Normal	Normal	Yes	No	No	No	No	No	Yes
16	57	Male	ALS	2	Yes	Yes	Yes	Yes	Yes	1	2	4	No	No	Normal	Normal	Normal	Yes	Yes	Yes	No	No	No	Yes
17	59	Male	ALS	1.5	Yes	Yes	Yes	Yes	No	2	3	1	No	No	Abnormal	Normal	Normal	No	No	No	No	No	No	No
18	55	Female	Postpolio syndrome	1	No	Yes	No	No	No	1	1	2	Yes	No	Normal	Normal	Abnormal	Yes	No	No	No	No	No	Yes
19	54	Male	ALS	1.7	Yes	Yes	Yes	Yes	No	3	2	3	No	No	Normal	Normal	Normal	No	No	No	No	Yes	Yes	Yes
20	65	Male	ALS	1.2	Yes	Yes	Yes	Yes	Yes	2	3	3	No	No	Abnormal	Normal	Normal	Yes	Yes	Yes	No	No	No	No
21	52	Male	ALS PLUS	2.8	Yes	Yes	Yes	Yes	No	2	2	1	No	No	Normal	Normal	Normal	No	Yes	No	No	No	No	No
22	48	Male	MMNCB	2.4	Yes	No	Yes	Yes	No	2	2	3	Yes	No	Normal	Normal	Abnormal	No	No	Yes	No	No	Yes	No
23	61	Male	ALS	3	Yes	Yes	Yes	Yes	Yes	2	2	5	No	No	Normal	Normal	Normal	Yes	Yes	Yes	No	Yes	No	Yes
24	53	Male	ALS	1.9	Yes	Yes	Yes	Yes	No	2	2	4	No	No	Abnormal	Normal	Normal	No	No	No	No	Yes	Yes	Yes
25	61	Male	Cervial Radiuclopathy	1.2	Yes	Yes	No	Yes	No	1	1	2	No	Yes	Normal	Normal	Abnormal	Yes	Yes	No	No	No	No	No
26	43	Male	BFS	6	No	No	No	No	No	3	2	3	Yes	No	Normal	Normal	Normal	Yes	No	No	No	No	Yes	Yes
27	51	Female	ALS	1.2	Yes	Yes	Yes	No	No	1	3	2	No	No	Normal	Normal	Normal	Yes	No	No	No	No	Yes	Yes
28	38	Male	Bibrachial MND	4.5	Yes	Yes	No	Yes	No	1	2	3	No	No	Normal	Abnormal	Normal	Yes	Yes	No	No	No	No	Yes
29	57	Male	ALS	2.3	Yes	Yes	Yes	Yes	No	3	3	5	Yes	No	Normal	Normal	Normal	Yes	Yes	No	No	Yes	Yes	Yes
30	63	Female	ALS	1.8	Yes	Yes	Yes	Yes	Yes	2	1	2	Yes	No	Normal	Normal	Normal	No	No	No	No	No	Yes	Yes

INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE, CHENNAI-3

EC Reg No.ECR/270/Inst./TN/2013
Telephone No : 044 25305301
Fax : 044 25363970

CERTIFICATE OF APPROVAL

To
Dr.J. Manickavasagam,
PG in DM Neurology,
Madras Institute of Neurology,
Madras Medical College, Chennai-3.

Dear **Dr.J. Manickavasagam,**

The Institutional Ethics Committee of Madras Medical College, reviewed and discussed your application for approval of the proposal entitled **"Usefulness of Ultrasound Assessment of Fasiculations in Neurological Disease"** No.06022013

The following members of Ethics Committee were present in the meeting held on 05.02.2013 conducted at Madras Medical College, Chennai-3.

1. Dr. G. Sivakumar, MS FICS FAIS	-- Chairperson
2. Prof. R. Nandhini, MD Director, Instt. of Pharmacology, MMC, Ch-3	-- Member Secretary
3. Prof. Shyamraj, MD Director i/c, Instt. of Biochemistry, MMC, Ch-3	-- Member
4. Prof. P. Karkuzhali, MD Prof. Instt. of Pathology, MMC, Ch-3	-- Member
5. Prof. Kalai Selvi, MD Prof. of Pharmacology, MMC, Ch-3	-- Member
6. Prof. Siva Subramanian, MD Director, Instt. of Internal Medicine, MMC, Ch-3	-- Member
7. Thiru. S. Govindasamy, BABL	-- Lawyer
8. Tmt. Arnold Saulina, MA MSW	-- Social Scientist

We approve the proposal to be conducted in its presented form.

Sd/Chairman & Other Members

The Institutional Ethics Committee expects to be informed about the progress of the study, and SAE occurring in the course of the study, any changes in the protocol and patients information / informed consent and asks to be provided a copy of the final report.

20/12/13

Member Secretary, Ethics Committee

MEMBER SECRETARY
INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE
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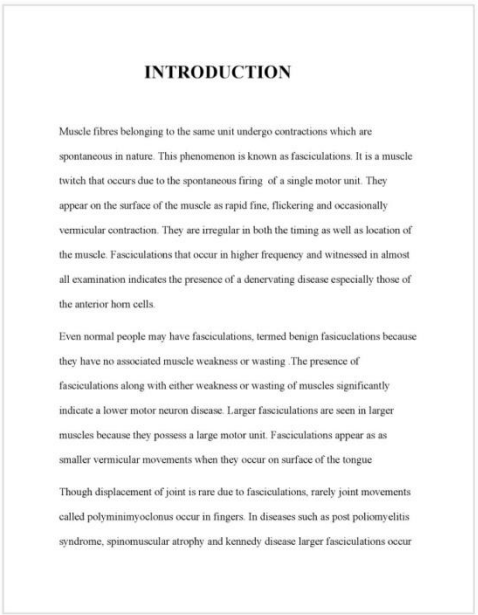
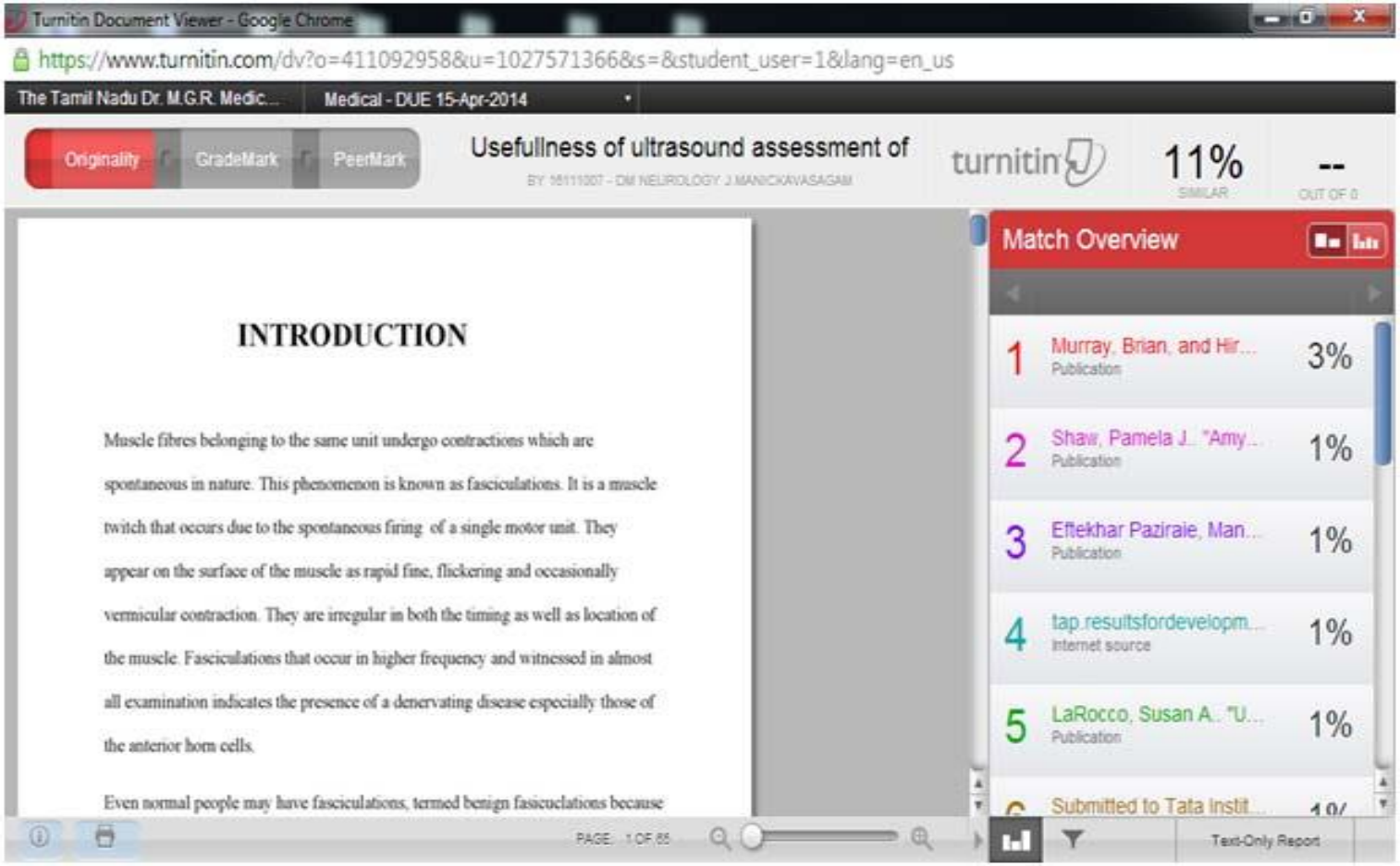


INTRODUCTION

Muscle fibres belonging to the same unit undergo contractions which are spontaneous in nature. This phenomenon is known as fasciculations. It is a muscle twitch that occurs due to the spontaneous firing of a single motor unit. They appear on the surface of the muscle as rapid fine, flickering and occasionally vermicular contraction. They are irregular in both the timing as well as location of the muscle. Fasciculations that occur in higher frequency and witnessed in almost all examination indicates the presence of a denervating disease especially those of the anterior horn cells.

Even normal people may have fasciculations, termed benign fasicuclations because they have no associated muscle weakness or wasting .The presence of fasciculations along with either weakness or wasting of muscles significantly indicate a lower motor neuron disease. Larger fasciculations are seen in larger muscles because they possess a large motor unit. Fasciculations appear as as smaller vermicular movements when they occur on surface of the tongue

Though displacement of joint is rare due to fasciculations, rarely joint movements called polyminimyoclonus occur in fingers. In diseases such as post poliomyelitis syndrome, spinomuscular atrophy and kennedy disease larger fasciculations occur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Muscle fibres belonging to the same unit undergo contractions which are spontaneous in nature. This phenomenon is known as fasciculations. It is a muscle twitch that occurs due to the spontaneous firing of a single motor unit. They appear on the surface of the muscle as rapid fine, flickering and occasionally vermicular contraction. They are irregular in both the timing as well as location of the muscle. Fasciculations that occur in higher frequency and witnessed in almost all examination indicates the presence of a denervating disease especially those of the anterior horn cells.
Even normal people may have fasciculations, termed benign fasiculations because
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