



International Journal of Physical Education, Sports and Health

P-ISSN: 2394-1685
E-ISSN: 2394-1693
Impact Factor (ISRA): 5.38
IJPESH 2018; 5(4): 01-05
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www.kheljournal.com
Received: 01-05-2018
Accepted: 02-06-2018

Veena J
Lecturer, Kempegowda institute
of physiotherapy, KR Road, V.
V. Puram, Bangalore,
Karnataka, India

Balasarvanan
M.P.T, Professor, Kempegowda
Institute of Physiotherapy,
KIMS, V. V. Puram, Bangalore,
Karnataka, India

Dr. Shivakumar
M.S Ortho, Professor,
Kempegowda Institute of
Medical Sciences and R.C. V. V.
Puram, Bangalore, Karnataka,
India

Correspondence
Veena J
Lecturer, Kempegowda institute
of physiotherapy, KR Road, V.
V. Puram, Bangalore,
Karnataka, India

A study on the effectiveness of the transcutaneous electrical nerve stimulation and stump exercises versus ultrasound therapy and stump exercises in the treatment of phantom limb pain in below knee amputation

Veena J, R Balasarvanan and Dr. Shivakumar

Abstract

Background and Objectives: Below knee amputation is the surgical removal of lower limb segment in which the bone division performed a few centimeters distal to the tibial tuberosity. Phantom Limb Pain is painful sensation in the absent limb which affects 60% - 80% in Amputees. PLP described as shooting, stabbing, squeezing, throbbing and burning pain was assessed using VAS, WOMAC and Short form of McGill Pain Questionnaire. There are many types of treatment for PLP which includes medical, psychological and physiotherapy treatments which includes US Therapy, TENS, etc.

Methods: The study included 40 patients (n=40) between 30 – 60 years of age which fulfilled the Inclusion Criteria and thereby was randomly assigned into two groups, 20 in each group through Random Sampling Method. Group I were treated with TENS and SE and Group II were treated with UST and SE.

Results: The result of the study was assessed using Visual Analogue Scale, Questionnaire Scoring and Present Pain Index of Short Form of McGill Pain Questionnaire to measure the prognosis of the pain intensity in the treatment of phantom limb pain in below knee amputees.

The mean score of VAS for TENS and SE group compared between before treatment with $p > 0.861$ and after treatment with $p < 0.002$, the mean score of QS before treatment with $p > 0.603$ and after treatment with $p < 0.021$.

The mean score of VAS for UST and SE group compared between before treatment with $p > 0.861$ and after treatment with $p < 0.002$, the mean score of QS before treatment with $p > 0.603$ and after treatment with $p < 0.021$.

Conclusion: Both groups of patients showed significant improvement in the treatment, wherein the group involving TENS and Stump exercises showed a marked improvement when compared to US therapy and Stump Exercise at the end of the 15th Session.

Keywords: PLP- phantom limb pain, TENS- transcutaneous electrical nerve stimulation, US- Ultrasound. SF- MPQ short form of McGill Pain questionnaire, VAS visual analogue Scal

Introduction

Amputation is derived from the Latin word "amputare" (to excise, to cut out) [1]. Amputation is surgical procedure where the whole or a part of the limb is removed through one or more bones. An amputation is a removal of a limb, or part of a limb, that is no longer useful to and is causing great pain, or threatens health because of extensive infection. Physicians consider amputation as last resort [2]. Amputation is an acquired condition that results in the loss of a limb, usually from injury, disease, or surgery. Congenital (present at birth) limb deficiency occurs when an infant is born without part or all of a limb.

Below knee amputation is the surgical removal of lower limb segment in which the bone division performed a few centimeters distal to the tibial tuberosity. In below knee amputation the longest stump compatible with adequate soft tissue coverage is most satisfactory4.

Incidence

The incidence of amputation is higher in smokers5, rises steeply with age, with most amputations occurring in patients aged between 30 - 60 years, and is higher in men than.

women [6]. Diabetes is a significant factor in lower-limb amputation [7]. People with diabetes constitute 50% of all major lower limb amputees [8].

Pain

Amputees can experience two different types of pain: incisional stump pain and Phantom Limb Pain (PLP). Stump pain is localized to the area immediately around the stump and the amputation scar and is described by patients as 'pressing', 'throbbing', 'Burning' and 'squeezing'. If unresolved, such pain is considered to negatively affect wound healing and to impact on quality of life [9, 10]. Phantom Limb Pain is a common problem, affecting 60% - 80% of amputated patients [11] and is usually reported during the immediate postoperative period but can persist for up to two years [10]. In some cases, PLP can be a lifelong experience. It is literally pain experienced in the limb that has been amputated, and is often described as a crushing, tearing pain [12]. Ellis points out that a large percentage of patients undergoing amputation have experienced chronic pain before their operation [10]. Therefore, in some cases, a patient may exchange the pain of ischemia for that of PLP. Increasing pain may also be a sign of ischemia; this may not be obvious if the deeper tissue rather than the skin is ischaemic [11].

Transcutaneous Electrical Nerve Stimulation

TENS is the application of electrical stimulation to the skin via surface electrodes to stimulate nerve fibers, primarily for pain relief. Meyer and Fields (1972) were among the first to report the clinical use of TENS for the relief of chronic pain. A variety of TENS models are currently available ranging from single or dual channel to multichannel units. The single and dual channel units are invariably operated by a 9 V battery whereas multichannel units tend to be powered by mains electricity. The majority of TENS units have belt clips so that the patient can wear TENS while mobile. The original TENS electrode was made of carbon rubber which was covered evenly with conductive gel (wet gel) and then applied to the skin with adhesive tape. We can use disposable hydrogel pads applied directly to the carbon rubber electrode. In recent times self-adhesive electrode type is used which can effectively mold to irregular shaped areas of the body [13, 14].

TENS reduces pain perception by 4 mechanisms. They are:

1. Gate control theory.
2. Opiate mediated control theory.
3. Local vasodilatation of blood vessels in ischemic tissue.
4. Stimulation of acupuncture points causes a sensory analgesic effect [15, 16, 17].

Ultrasound Therapy

Ultrasound Therapy refers to the mechanical vibrations, which are essentially the same as sound waves but of a higher frequency. Ultrasound transmission occurs when a high frequency potential field (1 – 3 MHz) is applied to a crystal in the ultrasound "transducer head" which then vibrates to produce a high frequency acoustic wave. Aqua sonic gel is used for the conduction of Ultrasound waves into the tissues. The therapeutic effects of heat likely involve increases regional blood flow, increases soft tissue extensibility and decreases pain and muscle spasm [18].

The short form of the McGill Pain Questionnaire (SF-MPQ)

- Is used to quantify a patient's pain experience.
- It consists of a series of pain descriptors describing

different aspects of the pain experience.

- The SF-MPQ usually takes around five to ten minutes to complete.

The main component of the SF-MPQ consists of 15 descriptors (11 sensory; 4 affective) which are rated on an intensity scale as 0 = none, 1 = mild, 2 = moderate or 3 = severe. Three pain scores are derived from the sum of the intensity rank values of the words chosen for sensory, affective and total descriptors. The SF-MPQ also includes the Present Pain Intensity (PPI) which has 5 grades, 0 = no pain, 1 = mild pain, 2 = discomforting, 3 = distressing, 4 = horrible and 5 = excruciating [19].

The Visual Analogue Scale (VAS)

- The VAS is a simple robust pain measurement tool.
- The VAS is usually designed as a 10cm line, with descriptors at each end [20].

Stump Exercises (SE)

Exercises are begun immediately after amputation. Deconditioning with bed rest is rapid and must be prevented with physical therapy. The affected limb should be exercised and joint contractures are prevented by means of range-of-motion exercises and positioning. Joint contractures occur rapidly in the presence of edema.

Exercising a few times a day will give relief from phantom limb pain by increasing circulation, strengthening the muscles and improving the range of movement. The exercises will also reduce swelling and the chance of developing contractures will be prevented.

Types of exercises are

Limb positioning, Isometric exercises, Stretching exercises, strengthening exercises.

Objectives of the Study

1. To compare the effectiveness of Transcutaneous Electrical Nerve Stimulation with Stump Exercises and Ultrasound Therapy with Stump Exercises in reduction of Phantom Limb Pain significantly on the Visual Analogue Scale (VAS) in below knee amputees.
2. To compare the effectiveness of Transcutaneous Electrical Nerve Stimulation with Stump Exercises and Ultrasound Therapy with Stump Exercises in reduction of Phantom Limb Pain significantly on the Questionnaire Scoring and Present Pain Index of Short Form of McGill Pain Questionnaire (SF-MPQ) in below knee amputees.

Methodology Source of Data

All patients coming to kempgowda institute of medical sciences, hospital and research center and Kempgowda Institute of Physiotherapy with below knee amputation and with phantom limb pain who are fulfilling the inclusion and the exclusion criteria.

Method of Collection of Data

Sample size: 40 (20 in each group).

Period of study: 1 year.

Study design: comparative study.

Sampling method: Random sampling method.

Inclusion Criteria

- Patients with below knee amputation.
- Patients complaining of Phantom Limb Pain after surgery.

- Patients between 30 to 60 years of age group of both sexes.
- Healed scar after suture removal.

Exclusion Criteria

- Dementia.
- Patients with pace maker.
- Patients with cardiac problems.
- Any skin diseases.
- Uncontrolled diabetes mellitus with unhealed scars.
- Stump neuroma conditions.
- Uncooperative patients.

Materials

Materials used for assessment

1. Patient's Consent Form.
2. Assessment Proforma.
3. Couch.
4. Short Form of McGill Pain Questionnaire (SF- MPQ).
5. Visual Analogue Scale (VAS).

Materials Used For Treatment

1. Table.
2. Couch.
3. Pillow.
4. Towel.
5. TENS Machine.
6. Ultrasound Machine.
7. Aqua sonic gel.
8. Adhesive tape.
9. Cotton.

Parameters Tens

Electrodes: Bipolar. Frequency: 1-20Hz.
Time: 20-30Mins.
Duration: 2Weeks

Ultrasound

Frequency: 1.0MHz.
Intensity: 1.0W/Cm
Mode: Continuous.
Time: 5-7Mins.
Duration: 2Weeks.

Procedure

All patients with Phantom Limb Pain in below knee amputees were assessed and those who fulfilled the inclusion criteria alone were selected and assigned to Transcutaneous Electrical Nerve Stimulation and Stump Exercises and Ultrasound Therapy and Stump Exercises groups. Before starting the treatment, the patient is positioned comfortably and assessed thoroughly about his or her condition. The following study included 40 patients between 30 – 60 years of age and was randomly assigned into two groups, 20 in each group. Group I were treated with TENS and SE and Group II were treated with UST and SE.

The study was conducted at the outpatient clinic of the Department of Physical Medicine and Rehabilitation, Kempegowda Institute of Physiotherapy, Bangalore. Subjects were diagnosed by a certified medical practitioner as having PLP in below knee amputees. Prior to include, subjects were informed about the study and a written consent was taken from the subjects. All patients were initially questioned about age, sex occupation and duration of PLP. Patients were closely questioned on past and present medications.

Procedure for Measuring Visual Analogue Scale (V.A.S):

All the subjects were evaluated for pain. V.A.S. was used (Melzack and Wall 1994) to measure the pain; ten-centimeter scale was taken to measure the intensity of pain in the individual. Recording was done before and after the treatment session.

Procedure for Measuring Short Form of McGill Pain Questionnaire (SF-MPQ)

SF-MPQ was used to measure the pain. It provides to the patients a list of frequently endorsed pain, factors that exacerbate their pain is noted. Checklists are available to assist patients

Technique of Application of Tens

Position the patient comfortably in supine lying position with pillow below the stump. The treatment part is cleaned with cotton soaked in water to reduce skin resistance. Place the bipolar electrodes coated with the aqua sonic gel over the stump with the help of adhesive tape. Check the intensity knob at zero. Therapist explains about the treatment method and the sensation felt by the patient during the treatment. Increase the intensity knob till patient feels mild tingling sensation. Frequency is set at 1-20Hz.and duration of the treatment is set for 20-30 Mins per session and after the treatment session the electrodes are removed from the treated part. The treatment is given continuously for 2 weeks.

Technique of Application of Ultrasound Therapy

Position the patient comfortably in supine lying position with a towel role below the stump. The treated part is cleaned with cotton soaked in water to reduce skin resistance. The Ultrasound probe coated with aqua sonic gel is placed over the stump, the therapist selecting the continuous mode starts moving the probe in small concentric circular movements by slowly increasing the intensity knob up to 1.0W/Cm² with the frequency of 1.0MHz and duration of the treatment is set for 5-7 Min per session. The treatment is given continuously for 2 weeks.

Technique of Application of Stump Exercises

The exercises that are taught to the patients are:
Stretching exercises: Hold for 30 seconds, 5 repetitions per session and 3 sessions per day.
Hip flexor stretch: Patient in supine lying position non-amputated leg is flexed at knee and draw towards the chest therapist slowly resists the amputated limb at knee to prevent flexion at hip in turn leads to hip flexor stretch.
Adductor stretch: Patient is sitting against the wall and non-amputated limb is flexed at knee, abducted and external rotated and amputated leg passively abducted in turn causes adductor stretching.
Strengthening exercises: Hold for 30 seconds, done for 10 repetitions per session and

Sessions per day

Static quadriceps: Patient in supine lying position, a towel role is given below theknee joint of the amputated limb and asked to press the towel in turn strengthens the quadriceps muscles.

Prone hip extension: Patient in prone lying position and asked to extend the hip of the amputated limb.

Side lying with hip abduction: Patient in side lying position and asked to abduct the hip of the amputated limb.

Statistical Software

The Statistical software namely SPSS 10.0 was used for the analysis of the data and Microsoft Word and Microsoft Excel was used to generate graphs and table.

Results

The study comprising of 40 subjects were divided into two groups viz, TENS and SE group consisting of 20 (50.0%) subjects and the rest of 20 (50.0%) in UST and SE group. Among the 20 subjects in TENS and SE group there were 14 (70.0%) males and 6 (30.0%) were females. In case of UST and SE group 15 (75.0%) were males and 5 (25.0%) were females. Thus, there is a preponderance of male subjects in both the groups in this study. The mean \pm SD of age in TENS and SE group was 47.5 ± 7.34 years and for UST and SE group it was 49.15 ± 6.28 years. Nevertheless, there was no statistical significance between the age distributions of subjects in both the groups. This revealed that in TENS and SE group the mean \pm SD of VAS score before treatment was 6.55 ± 1.85 and after treatment it was 1.25 ± 1.16 . In case of UST and SE group the mean \pm SD before treatment was 6.45 ± 1.73 and after treatment it was 2.70 ± 1.59 .

The mean \pm SD of QS score for TENS and SE group before treatment was 10.65 ± 3.39 and after treatment it was 2.50 ± 1.64 . Whereas in case of UST and SE group it was observed to be 11.25 ± 3.82 before treatment and 3.95 ± 2.14 after treatment.

The mean \pm SD of PPI score for TENS and SE group before treatment was 3.95 ± 0.83 and after treatment it was 0.75 ± 0.72 . Whereas in case of UST and SE group it was observed to be 4.15 ± 0.75 before treatment and 1.75 ± 0.97 after treatment.

The VAS, QS and PPI score which was recorded before and after treatment were analyzed statistically. It was noticed that the changes in the mean score of VAS for TENS and SE group compared between before treatment (6.55 ± 1.85 , $p > 0.861$) and after treatment (1.25 ± 1.16 , $p < 0.002$). And for changes in the mean score of QS before treatment (10.65 ± 3.39 , $p > 0.603$) and after treatment (2.50 ± 1.64 , $p < 0.021$).

And the changes in the mean score of PPI before treatment (3.95 ± 0.83 , $p > 0.426$) and after treatment (0.75 ± 0.72 , $p < 0.001$).

And it was noticed that the changes in the mean score of VAS for UST and SE group compared between before treatment (6.45 ± 1.73 , $p > 0.861$) and after treatment (2.70 ± 1.59 , $p < 0.002$). And for changes in the mean score of QS before treatment (11.25 ± 3.82 , $p > 0.603$) and after treatment (3.95 ± 2.14 , $p < 0.021$). The changes in the mean score of PPI before treatment (4.15 ± 0.75 , $p > 0.426$) and after treatment (1.75 ± 0.97 , $p < 0.001$). It may be seen here that in TENS and SE group the changes were noticed and was significant at the end of the 15th treatment session and even for UST and SE the changes were noticed and was significant at the end of the 15th treatment session. And both groups were statistically significant.

Table 1: age and gender distribution of the subject

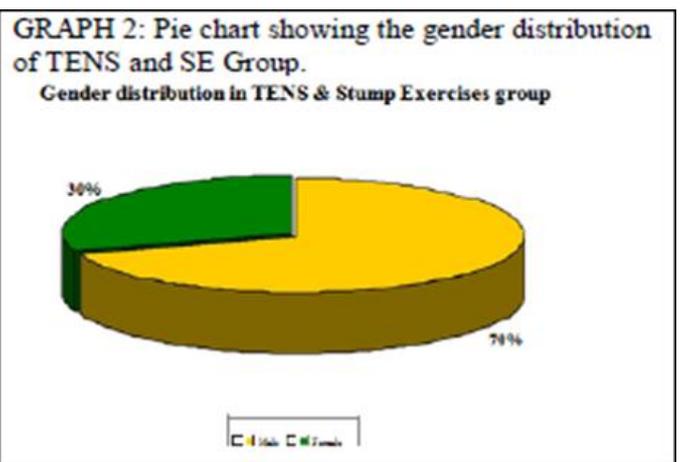
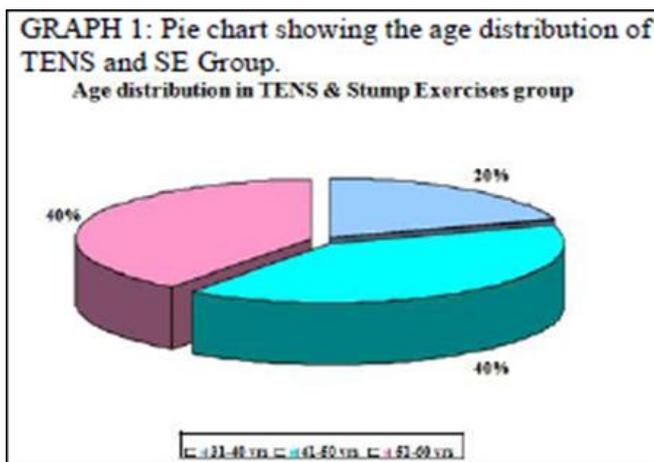
Age year	Tens and see group			UST and SE group			Grand total
	Male	female	total	Male	female	total	
31-40	4	0	4	1	0	1	5
41-50	6	2	8	10	1	11	19
51-60	4	4	8	4	4	8	16
Total	14	6	20	15	5	20	40

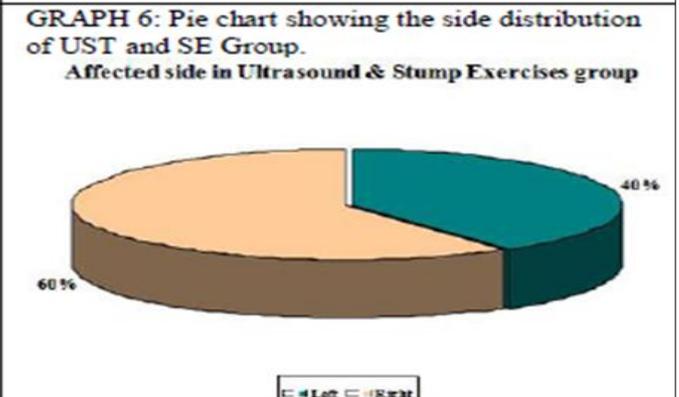
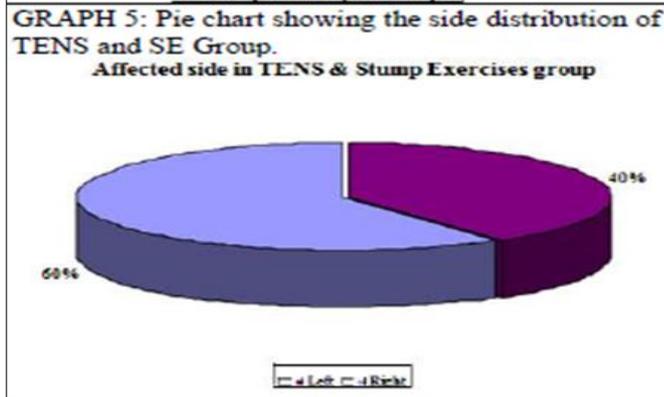
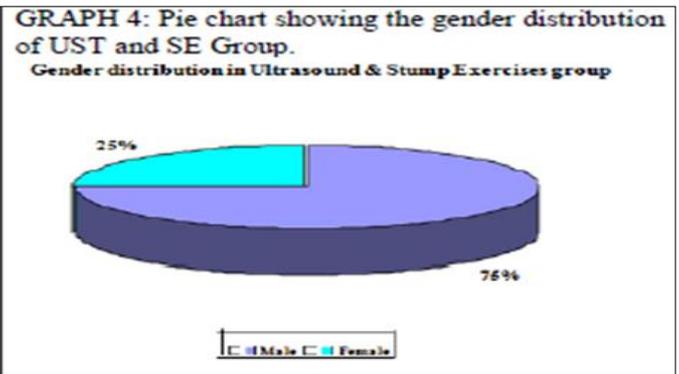
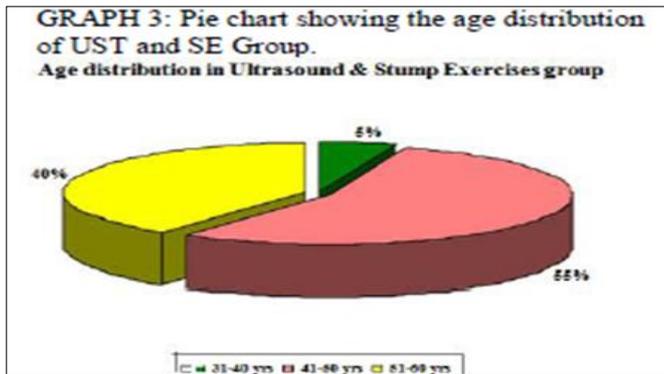
Table 2: side distribution of the subjects

group	side		total
	Right	left	
Tens ANS se	12	8	20
UST	12	8	20

Table 3: descriptive statistics of vas score during pre and post treatment in the two group

Pre and post treatment vas			
Parameter	Group	Mean+SD	p-value
PRE VAS	TENS and SE	6.55 ± 1.85	0.861
	UST and SE	6.45 ± 1.73	
POST VAS	TENS And SE	1.25 ± 1.16	0.002





Conclusion

In this study, Visual Analogue Scale, Questionnaire Scoring and Present Pain Index of Short Form of McGill Pain Questionnaire were used to measure the prognosis of the pain intensity in the treatment of phantom limb pain in below knee amputees was determined.

Taking into consideration the parameters of pain using the mean score of Visual Analogue Scale, Questionnaire Scoring and Present Pain Index in case of Transcutaneous Electrical Nerve Stimulation and Stump Exercises group was compared with Ultrasound Therapy and Stump Exercises group.

Since, the mean score of Visual Analogue Scale, Questionnaire Scoring and Present Pain Index showed a significant improvement in both the groups. But the Transcutaneous Electrical Nerve Stimulation and Stump Exercises group showed better improvement compared with Ultrasound Therapy and Stump Exercises group.

Hence, the Transcutaneous Electrical Nerve Stimulation and Stump Exercises group is better line of treatment than Ultrasound Therapy and Stump Exercises in treating Phantom Limb Pain in below knee amputees.

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