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Research Article

Comparative Efficacy of Soft Tissue Massage and Transcutaneous Electric Nerve Stimulation in the Management of Hemiplegic Shoulder Pain

***Badaru U.M. and Aminu S**

Department of Physiotherapy, Faculty of Allied Health Sciences, Bayero University, Kano, Nigeria

Summary: Hemiplegic Shoulder pain (HSP) is a common clinical consequence of focal cerebral insult. The study investigated the comparative efficacy of Transcutaneous Electrical Nerve Stimulation (TENS) and Soft Tissue Massage (STM) in the management HSP. A total of 50 consenting stroke patients with HSP completed the 8 weeks pretest posttest quasi-experimental study. They were assigned into either TENS or STM groups using simple random sampling. Both TENS and STM treatments were administered on subscapularis, supraspinatus and posterior deltoid muscles for 16 sessions. HSP was evaluated pre and post intervention with visual analog scale. Within and between group differences in HSP were compared using paired and unpaired t-tests respectively with SPSS version 16.0 with probability level of 0.05 to indicate level of significance. The age of patients in the TENS and STM groups was 56±9.26years and 57±7.51years respectively. Duration of stroke was 10±6 months and 9±4 months for TENS and STM groups respectively. There was no significant between group differences in HSP at baseline (TENS=4.76±2.17; STM=5.48±2.06; p>0.05). Within group comparison of HSP scores pre and post intervention in the TENS group indicated a significant reduction (P<0.05); also the same applies to STM group (P<0.05). When the post treatment HPS scores were compared across the groups, there was a significant difference in favor of TENS group (TENS=1.48±0.51; STM=2.12±1.17; p<0.05). Both TENS and STM contribute to the modulation of HSP in stroke patients and each could become handy in augmenting other forms of management. However, TENS is more effective.

Keywords*: Hemiplegic shoulder pain, TENS, Soft Tissue Massage, Subscapularis, Deltoid, Supraspinatus*

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**Address for correspondence: umbadaru.pth@buk.edu.ng ; Tel: +234-8035913759*

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INTRODUCTION

Shoulder pain has negative impact on the discharge of economic, family and social roles (Yeun, 2017). Hemiplegic shoulder pain (HSP) hampers physical function (Joshi and Chitra, 2017) and negatively influenced the outcome of stroke rehabilitation (Walsh, 2001; Poenaru *et al*, 2008; Joshi and Chitra, 2017). It occurs commonly 2-3 months post stroke (Poduri 1993). Common causes of HSP include poor handling and positioning of the affected upper limb (Walsh, 2001), joint subluxation due to flaccidity of rotator cuff muscles (Yu *et al* 2004; Teasell *et al*, 2012) and spasticity (Yu *et al*, 2004; Paci *et al*, 2005; Poenaru *et al*, 2008; Chuang *et al*, 2017; Zhou *et al*, 2018).

Transcutaneous Electric Nerve Stimulation (TENS) is a physiotherapy modality that is frequently used in the management of HSP. It has been reported being effective in relieving HSP (Leandri *et al*, 1990; Ekim *et al*, 2008; Poenaru *et al*, 2008; Moniruzzaman *et al*, 2010; Joshi and Chitra, 2017) and improving upper extremity function (Poenaru *et al*, 2008; Joshi and Chitra, 2017) especially when administered in conjunction with conventional physiotherapy. Some studies have however found that TENS was less effective than other forms of therapy such as neuromuscular electrical stimulation (NMES) (Chuang *et al*, 2017; Zhou *et al*, 2018) and manual tapping technique (Tiwari *et al*, 2018) while the study by de Jong *et al*, (2013) and Bello and Amaezo (2009) reported respectively that NMES and TENS are not effective in HSP modulation. The conflicting report on the efficacy of TENS was due largely to the great variation that exist in the technique of TENS application on the shoulder and in the choice of the shoulder muscles to be treated. Soft Tissue Massage (STM) is another modality commonly used by physiotherapists to manage HSP (Karels *et al*, 2006; Bennell *et al*, 2007, Bello and Amaezo, 2009). A recent systematic review suggested that STM is effective in reducing shoulder pain from causes other than stroke (Yeun, 2017). Todate only the study by Mok and Woo, (2004) shows that STM significantly reduced HSP hence further research is needed to provide recommendations that are based on empirical evidence. This study therefore investigated the comparative efficacy of TENS and STM in the management HSP with both treatments applied on subscapularis, supraspinatus and posterior deltoid muscles..

MATERIALS AND METHODS

The pretest posttest quasi-experimental comparative study was carried out at the departments of physiotherapy of Aminu Kano Teaching Hospital (AKTH) and Murtala Muhammad Specialist Hospital (MMSH), Kano. Ethical approval was obtained from the ethics committees of AKTH and the Kano State Hospital Management Board for

MMSH. A total of 56 participants met the inclusion criteria; they were consecutively recruited and randomly assigned into the 2 groups as they become available. Participants that met the inclusion criteria include all stroke patients diagnosed with HSP with the exception of those with insensate skin, diagnosis of shoulder subluxation, pre-stroke history of frozen shoulder, trauma or brachial plexus injury and those who were presently on prescribed pain medications. The aims, objectives and study procedures were explained to each of the participants. Thereafter they were asked to give written informed consent of participation which they all did. The consent included beneficence, voluntariness, confidentiality and anonymity which were duly respected.

Procedure for Random Assignment into Treatment Groups: Each of the patients was asked to pick a single paper without replacement from a bowl containing a mixture of 56 folded papers that were thoroughly mixed together (letter 'A' was written on 50% of the folded papers while letter 'B' was written on the remaining 50%). Each patient was assigned to the group he/she picked. Participants who picked letter 'A' were assigned to the TENS group while those who picked letter 'B' were the STM group. Visual analog scale was used to assess level of HSP at baseline and post intervention. TENS unit (Enraf Nonius, Vamed Engineering, Serial No-PE0007-KN-005) was used for treatment of HSP. The STM was done manually with olive oil being used as massage medium. Methylated Spirit was used to sterilize the shoulder areas to be treated.

Assessment of Level of Hemiplegic Shoulder Pain: This was assessed at baseline and post intervention periods by a blinded assessor using the visual analog scale. The participants were asked to rate their level of shoulder pain from 'no pain' or score of zero (0) to 'worst pain' or score of ten (10).

Range of Motion Exercise: All the study participants regardless of their group assignment received both passive and active range of motion exercises to the affected shoulder complex for 5 minutes pre and post TENS or STM treatments.

Procedure for TENS Treatment: Participants in the TENS therapy group were asked to shave their axillar. Each of the patients was asked to assume side lying posture on the unaffected side. Low frequency TENS (frequency, 80HZ, phase duration 60μs) was applied for 10 minutes on each of subscapularis posterior deltoid and supraspinatus muscles twice weekly x 8 weeks. Each of the 2 TENS electrodes was placed on either end of the supraspinatus muscle. They were thereafter, placed along the length of the posterior deltoid muscle. Similar technique for determination of the bellies of supraspinatus and posterior deltoid muscles and electrode placements was reported in recent study (Chuang *et al*. 2017). Furthermore, one of the electrodes was placed in the origin of the subscapular nerve in the neck and while the other one was placed in the posterior wall of the axilla as contained in Gulick *et al*, (2007) for the stimulation of subscapularis muscle. In the study by Thurner *et al*, (2013) therapy targeting the subscapularis muscle belly was administered on the posterior wall of the axilla with the patient's shoulder in abduction. The TENS therapy session lasted 40 minutes (each of the 3 muscles received 10 minutes of TENS with 5 minutes of ROM exercises before and after TENS treatment)

Procedures for STM: The patients in the STM group were asked to assumed side lying posture on the unaffected side. The bellies of the specific muscles to be treated (subscapularis, posterior deltoid and supraspinatus) were identified in the similar way it was done for electrode placement. Slow stroking STM was administered directly on posterior deltoid and supraspinatus muscles for 10minutes each twice weekly for 8weeks. However because of the hidden nature of the subscapularis muscle (it is located between scapular and thorax), the STM was done indirectly by the gentle gliding of scapular on the thoracic wall for 10 minutes twice weekly for 8weeks.
Each STM session lasted 40 minutes (each of the 3 muscles had STM for 10 minutes in addition to 5 minutes of ROM exercises before and after STM). Participants in both groups were asked to continue with their routine gait training, however any form of exercise or therapy to the shoulder joint was not allowed, participants only received TENS or STM in addition to ROM for treatment of their HSP during the period of the study.

Data Analysis Procedure: Demographic characteristics of the study participants were analyzed using descriptive statistics of mean and standard deviation. Both within and between group differences were analysed using inferential statistics of paired and independent sample t-test respectively. All statistical analysis was performed using statistical package for social sciences (SPSS) version 16.0 with probability level of 0.05 to indicate level of significance

RESULTS

The 50 participants that completed the study comprised TENS Group with 25 patients, 14 males (56%) and 11 females (44%) while the 25 patients in the STM group comprised 15 males (60%) and 10 females (40%). The mean age of participants in the TENS group was 56years, while that of STM group was 57years as presented in Table1.

Table1.
Physical Characteristics of Stroke Patients (N=50)

VARIABLES		GROUP A	GROUP B
Age (years)		56± 9.26	57±7.51
Duration of stroke (months)		10±6	9±4
		n (%)	**n (%)**
Gender	Male	14(56)	15 (60)
	Female	11(44)	10 (40)
	Total	25(100)	25(100)
Occupation		**n (%)**	**n (%)**
	Unemployed	11(44)	10(40)
	Self-employed	5(20)	8(32)
	Civil-servant	9(36)	7(28)
	Total	25(100)	25(100)
Side of hemiplegia		**n (%)**	**n (%)**
	Right	15(60)	11(44)
	Left	10 (40)	14(56)
	Total	25(100)	25(100)

SD=Standard Deviation; N=Sample Size; n=Frequency; %=Percent

Table 2.
Between Group Comparison of HSP Scores at Baseline and Post Intervention Periods

Variables	N	Mean ± SD	df	t	P
Baseline					
TENS Group	25	4.76 ± 2.17	48	-1.20	0.24
STM Group	25	5.48 ± 2.06			
Post intervention					
TENS Group	25	1.48 ± 0.51	48	-2.51	0.02*****
STM Group	25	2.12 ± 1.17			

*SD=standard deviation; df=degree of freedom *=Significant; TENS=Transcutaneous Electric Nerve Stimulation; STM=Soft Tissue Massage*

Table 3.
Within-Group Comparison of HSP Scores Pre and Post Interventions in TENS and STM Groups

Variables	N	Mean ± SD	df	t	P
Group A					
HSP Pre-intervention	25	4.76 ± 2.17	24	-1.20	0.000*
HSP Post-intervention	25	1.48 ± 0.51			
Post intervention					
HSP Pre-intervention	25	5.48 ± 2.06	24	-2.51	7.40
HSP Post-intervention	25	2.12 ± 1.17			

*N= no of participants; M=mean; SD=standard deviation; df = degree of freedom *significant*

Between-group comparison of HSP at baseline using independent samples t-test showed insignificant difference in HSP scores before the interventions (P>0.05). At the end of 8 weeks of intervention, there was significant difference in HSP between the 2 groups with the TENS group having significantly lower pain scores (P<0.05) as presented in table 2. The result of within-group comparisons of pre and post intervention scores of HSP in STM group was significant (P<0.05). Furthermore, the result of within-group comparison of pain scores pre and post intervention periods in the TENS group was also significant (P<0.05). These results are presented in Table 3.

DISCUSSION

This study compared the effectiveness of TENS and STM in the management of HSP with both therapies being applied on supraspinatus, posterior deltoid and subscapularis muscles. The result this study showed that TENS has significant effect on HSP and this implies that TENS therapy can be used to effectively reduce HSP. The outcome of this study as regards the effectiveness of TENS in the management of HSP is in consonance with the reports of other studies where it was equally reported being effective in reducing HSP and improving functional use of the affected upper extremity especially when used in conjunction with conventional physiotherapy (Leandri *et al*, 1990; Ekim *et al*, 2008; Poenaru *et al*, 2008; Moniruzzaman *et al*, 2010; Joshi and Chitra, 2017). The outcome of this study was however different from that of Bello and Amaezo, (2009) who found on the other hand that TENS therapy was not effective in the management of HSP probably due to the fact that TENS was to treat the entire shoulder joint. In the present study, however, the TENS therapy targeted specific muscles that stabilize the glenohumeral joint and the exact points of TENS application has been clearly highlighted.

It was further found in the present study that STM significantly reduced HSP. This implies that STM can potentially be used to reduce shoulder pain post stroke. The finding of the present study on STM is in consonance with the reports of Mok and Woo (2004) which showed that slow-stroking STM significantly reduced HSP. The possible reason for the similarity between our finding and that of Mok and Woo (2004) could because the type of STM used was similar in both studies. The outcome of this study supported the finding of the systematic review by Yeun, (2017) that STM could effective in reducing shoulder pain from various aetiologies.

Additionally, the present study found that TENS therapy decreased HSP more significantly than STM. This is because participants who received TENS therapy recorded significantly less pain scores at the end of the last treatment. This implies that TENS is more effective than STM in the management of HSP. Similar studies have also reported that TENS was more effective than galvanic current (Poenaru *et al*, 2008) and ultrasonic therapy (Moniruzzaman *et al*, 2010) in the management of HSP. Although some studies have reported that other modalities such as NMES (Chuang *et al*, 2017; Zhou *et al*, 2018) and manual tapping technique (Tiwari *et al*, 2018) were more effective when compared with TENS in the management of HSP, probably because the studies did not include subscapularis as one of the target muscles in the management of HSP. Even in a study in which the subscapularis muscle was the primary target, the exact point of application of therapy on the scapularis muscle was not clearly stated (Poenaru *et al*, 2008). Though supraspinatus and posterior deltoid are important muscles in maintaining the correct alignment and stabilization of the glenohumeral joint (Paci *et al*, 2005; Zhou *et al*, 2018), the subscapularis muscle could be the chief culprit and a major cause HSP that is often overlooked. Being the major internal rotator of the shoulder, the subscapularis is part of the typical flexor synergy in patients with spastic hemiplegia that usually produce pain during shoulder abduction, flexion and external rotation (Teasell *et al*, 2012). Trigger points in the subscapularis muscle may produce increased pain sensitization and significant muscle guarding that restricts mobility of shoulder joint (Thurner *et al*, 2013).

In view of the result obtained from this study, it can be concluded that both TENS and STM therapies can significantly reduce HSP post stroke when the treatment targeted supraspinatus, posterior deltoid and subscapularis muscles. TENS is however more effective than STM in the modulation of HSP when applied in conjunction with ROM exercise.

Based on the results of this study, it was recommended that TENS should be considered the first treatment of choice in management of HSP. Further studies should be conducted to find the efficacy of TENS and STM therapies combined.

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