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IMMEDIATE EFFECT OF ACUTE PRESSURE STIMULATION OF SCIATIC NERVE ON PAIN AND RANGE OF MOTION IN OSTEOARTHRITIS OF KNEE: A RANDOMIZED CONTROLLED TRIAL

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Abstract :

The objective was to evaluate the immediate effect of acute pressure stimulation of sciatic nerve on pain and active and passive knee range of motion in subjects with osteoarthritis of knee. A total of 36 subjects were included and were randomized into 2 groups consisting of 18 subjects each. Group A received the placebo press and Group B received the sciatic nerve pressure stimulation for 2 minutes respectively. Pain during rest and four functional activities were recorded using the visual analogue scale and knee range of motion was recorded using the universal goniometer. Group B had reduction in pain in the affected knee during during walking, ascending and descending stairs and sit to stand and intra-group results were also significant for group B for rest, walking, ascending stairs, descending stairs, sit to stand post intervention. it was concluded that Acute pressure stimulation of the sciatic nerve is a safe and effective method abolish pain and improve the knee range of motion caused due to osteoarthritis of the knee

ISSN: 0974-8946
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KEY WORDS:

Osteoarthritis of knee, Acute pressure stimulation of sciatic nerve, Pain, Range of motion.

INTRODUCTION

Osteoarthritis of knee is among the most prevalent musculoskeletal complains which affect 30% to 40% of the population by the age of 65 years(1) and one of the major cause of impairment and disability among the elder population(2,3).The prevalence of knee osteoarthritis in India is highest among the age group of 60 years and above and found to be more prevalent in females by 31.6% than in males[4].Individuals with osteoarthritis of knee suffer progressive loss of function, displaying increasing dependency in walking, stair climbing and other lower extremity tasks(1).Acute pressure stimulation of the sciatic nerve is a newly reported analgesic method based on a current neuroscience concept: stimulation of the peripheral nerves increases the pain threshold.This method uses pressure to stimulate the sciatic nerve(5). The target of acute pressure stimulation of the sciatic nerve method is the sciatic nerve and this treatment provides relief from various pains in different areas of the body as proven by literature(6). Chemical, electrical and mechanical blocks of the sciatic nerve has reportedly generated analgesic effects(5).The reason behind chronic pressure on the sciatic nerve resulting in increased pain and acute pressure resulting in significant hypoalgesia is not clearly known.Few hypotheses which might explain the immediate analgesic effect of the acute pressure stimulation of the sciatic nerve(5) are the gate control theory of pain(7) and acid – sensitive ion channels(ASIC)(5).As there are few pain relieving modalities available for the treatment of osteoarthritis of knee this present study is indicated to evaluate the effect of acute pressure stimulation of the sciatic nerve for relieving the pain and improving the range of motion in osteoarthritis of knee .

MATERIALS AND METHODOLOGY

ISSN: 0974-8946
Vol. 47, Issue. 04: 2022

The study adopted a Randomized controlled trial and was conducted on 36 subjects through non- probability sampling design for a period of 3 months. Men and women diagnosed with osteoarthritis of knee of age group of 65 years to 75 years who had pain score of 4 or above according to the visual analogue scale in Belgavi city were included in the study.Subjects who had a history of neurological impairment, lower limb surgeries or deformities,administration of intra articular steroidal injections in the past 6 months were excluded from the study.

An approval for the study was obtained from the Institutional Ethical Committee. The participants were oriented about the study and a written informed consent was obtained from each participant. All the 36 participants were randomized in two groups, 18 in the control group and 18 in the intervention group.Group A was denoted as the control group which received placebo press and Group B received the acute pressure stimulation of the sciatic nerve for 2 minutes respectively.

OUTCOME MEASURES

Demographic data was collected before evaluating the pre- intervention outcome measures.The evaluation of the outcome measures was conducted pre- intervention and post-intervention.

The primary outcome measure was the evaluation of pain using visual analogue scale(VAS). The visual analogue scale of 10 cm in length was administered to the patient and they were asked to determine their pain levels/intensity on the scale using a pencil and marking a line on the 10 cm scale(8).The pain intensity during restand during four functional tasks like walking for 20 metres in the 20 mt walk test where the patient was asked to walk till completion of 20 metres, ascending 7 steps and descending 7 steps without support of the

ISSN: 0974-8946
Vol. 47, Issue. 04: 2022

handrails and five repetitions of sit to stand from a standard chair with arms folded across their chest(9)were noted at the beginning and at the immediate end of the protocol.

The secondary outcome measure was the active and passive flexionrange of motion of the knee using the universal goniometer where the affected knee flexion and extension was measured in the patient's prone lying position(10).

INTERVENTION

Group A contained 18 participants who received '**Placebo press'**. The participants were in the supine position. They had to expose the anterior thigh region of bilateral lower limbs. The therapist applied the pressure simultaneously on bilateral anterior thigh of the patient using their fists. The amount of pressure/force applied was in the range of 10 to 20 kgs, depending on the BMI of the patient(11,12). The pressure was applied for 2- 3 minutes using the dorsal,proximal phalangeal surface of the fists(11,12,13).

Group B contained 18 participants who received **'Sciatic nerve press'**. The participant was in the prone position. They exposed the posterior thigh region of bilateral lower limbs. The therapist applied the pressure simultaneously on bilateral posterior thighs using their fists. The therapist applied a pressure/force was in the range of 10 to 20 kgs, depending on the BMI of the patient along the course of the sciatic nerve. The pressure was applied simultaneously on the sciatic nerve of both the limbs. The pressure was applied for 2- 3 minsusing the dorsal, proximal phalangeal surface of the fists(11,12,13).The pressure applied by the therapist on the subject was measured in kg units. The amount of pressure to be applied by the therapist was established by repeatedly pressing the fists on a weighing scale to experience and learn how much force to use with each fist(11,12,13).The pressure range was from 10 kgs to 20 kgs

ISSN: 0974-8946
Vol. 47, Issue. 04: 2022

and the amount of pressure to be given was dependent on the subjects BMI.The BMI values are established by consensus statement for Asian Indians for 2009(14).

BMI (Kg/m^2)	**Amount of Pressure Received**
18.0 – 22.9Kg/m^2	10 – 12 kgs
23.0 - 24.9 kg/m^2	13 - 16 kgs
> 25 kg/m^2	17 – 20 kgs

Table 1: Pressure distribution according to BMI

STATISTICAL ANALYSES

Statistical analysis for the present study was done using statistical package of social sciences (SPSS) version 21 so as to verify the results obtained. Homogeneity between the groups in terms with height, weight, BMI, gender, affected side and mean pain duration was examined using t- test and chi- square test. The normality of all variables, pre test and post test scores in groups A and B was examined using Kolmogorov Smirnov test. The Mann Whitney U test and independent t test were used for analysis of the pre-intervention and post-intervention scores of both the groups. Confidence interval of 95 % and p value < 0.05 was considered statistically significant.

RESULTS

Both the groups exhibited similar general characteristics in terms of age, height, gender distribution, affected knee, mean pain duration in months except for weight and BMI which was found significant (Table 2). The normality distribution of all variables in respect to the

ISSN: 0974-8946
Vol. 47, Issue. 04: 2022

pre and post intervention scores in both the groups was found non-significant except for rest scores in group B and walking scores in group A.

Using Mann Whitney U test for analysing the pre and post intervention pain scores for both groups A and B for in terms of rest showed that statistical significance was achieved within the group by Group B with p = 0.0007 with a percent of change of 30.04% as compared to 18.26% in group A but no statistical significance was achieved between the groups. Statistical significance was reached for the walking scores within the groups (p=0.0001) with a percent of change in group B as 36.76% as compared to -28.86% in group A along with between the groups with p= 0.0001. The pre and post intervention pain scores for between the groups in terms of ascending and descending stairs had a p value of 0.0001 and within the groups had a p value of 0.0011 for group A (6.96%) and 0.0001 was group B (30.90%) which was statistically significant. Sit to stand were analysed using independent t test which showed that statistical significance was achieved between the groups (p=0.0016). The p values for within the groups were 0.0001 for both the groups but the percentage of change in group B (31.66%) was higher than compared to group A (8.90%)(Table 3).Analysis of pre and post intervention for the active and passive knee flexion range of motion was conducted using independent t test. The analysis found that the range of motion scores for active knee flexion for between the groups were statistically significant(p=0.0486) and for passive knee flexion was p=0.0397. The percentage of change in group B in terms of active flexion scores were 8.69 % as compared to 5.27% of group A. The percentage of change in group B in terms of passive flexion of the knee scores was – 2.59% as compared to – 1.34% of group A(Table 3)

DISCUSSION

Results showed that there was an improvement seen in both the groups, intervention and control, in respect to pain during walking, ascending and descending stairs, sit to stand except

ISSN: 0974-8946
Vol. 47, Issue. 04: 2022

the pain during rest in group A showed no improvement. The improvement was also seen in terms of active and passive knee flexion range of motion in both the groups. Though statistically both the groups showed improvement in the post intervention scores, the percent of improvement in group B was higher when compared to group A.

A novel analgesic method has been introduced known as the acute pressure stimulation of the sciatic nerve. This technique is based on the concept of stimulation of the peripheral nerves enhances the pain threshold level of the body. In this study, the pressure applied was on the course of the sciatic nerve i.e on the hamstrings / posterior region of bilateral lower limbs. This placement of the pressure on the sciatic nerve is similar to previous studies which investigated the effect of the acute pressure stimulation of the sciatic nerve on immediate pain relief conducted by He J et al(12). These studies noted that immediate pain relief was achieved when the pressure was applied on the accessible area along the sciatic nerve and the effectiveness of this technique was reduced when the pressure was applied distant from the sciatic nerve course.Many mechanisms have been stated to come into play in this technique which cause reduction in pain immediately.

One mechanism is the immediate inhibition of the wide dynamic response neurons which are present in the spinal dorsal horn. It is known that wide dynamic neurons are the first synaptic relay point for afferent pathways and have known to play a role in the modifications of the noxious stimuli transmission from the dorsal horn to the higher centres in the brain. According to the pain gate theory, stimulation of the large diameter afferent nerve fibres inhibit the 2^{nd} order neurons in the dorsal horns and this prevents the small diameter fibers to transmit the impulses further and this has known to bring about an inhibition of the wide dynamic response neurons which causes immediate pain relief(5).

ISSN: 0974-8946
Vol. 47, Issue. 04: 2022

The pain relief acquired from this technique is not concentrated to a particular region of the body but to various parts as seen in previously conducted studies(15). The reasoning for this could be the possible activation of multiple inhibitory systems in the body along with activation of the endogenous opoidsystems(15). A study done by Yao et alto study the long lasting cardiovascular depressor response following sciatic nerve stimulation in hypertensive rats showed that the low frequency stimulation of the sciatic nerve of the rat increased the pain threshold by 50 %. Naloxone infusion was given which attenuated the depressor response significantly, suggesting an important role of the brain endorphin system and hypalgesic effects produced are mediated via different types of opiate receptors in the brain(15).

Another mechanism is stated to be the presence of acid sensitive ion channels which are expressed in the sciatic nerve and the dorsal root ganglia. The Acid sensitive ion channels are proton gated ion channels present in the peripheral and central nervous system of the mammals.Sensory transduction in nerves is accomplished by ion channel proteins, which are gated pores that allow the exchange of ions across the membrane. They are proposed to constitute mechanoreceptors which play an important role in responses to mechanical stimuli(5). To date, four acid-sensitive ion channel proteins have been found to be expressed in the sciatic nerve(16).

The control group in this study received an application of pressure of the same range of 10 to 20 kgs of force on the anterior region of the thigh, bilaterally. The results showed that some amount of relief was perceived in the control group but was less compared to the intervention group. This effect maybe due to the pressure on the femoral nerves which are present on the anterior region of the thigh. There are no studies conducted to determine the effect of the pressure stimulation on the anterior thigh region on pain relief. So the results obtained from the control group may be due the placebo effect(11,12).

ISSN: 0974-8946
Vol. 47, Issue. 04: 2022

A study done by P creamer et al on factors associated with functional impairment in symptomatic knee osteoarthritis stated that function in symptomatic knee osteoarthritis was determined more by the intensity of pain as compared to structural changes in the knee joint(17) which explains the betterment in the functional activities after the intervention as the pain had decreased comparatively.The results also stated that the intervention group had better knee flexion ranges, both active and passive which are similar to the results obtained in the study conducted to understand the influence of pain on knee motion in patients with osteoarthritis undergoing total knee arthroplasty by Bennett D(18).They studied the effect of removing pain by testing Total knee arthroplasty patients' range of motion before and after the administration of anaesthesia and concluded thatabolition of pain led to significant increases in knee flexion, extension, and ROM, suggesting that pain has a significant inhibitory effect on knee motion(18).This study had few limitations like distribution of the population with higher BMI was in group B it could have led to the bias in the improvements seen which were higher in group B as compared to group A.

CONCLUSION

We conclude that the acute pressure stimulation of the sciatic nerve is a safe and effective method in order to abolish pain caused due to osteoarthritis of the knee. This novel technique is economical in nature and easy to administer under guided supervision.

FUTURE SCOPE

This technique can be used to evaluate its efficacy in reducing pain in other orthopaedic conditions. Also further studies can be done to determine its long term effects.

CONFLICT OF INTEREST: None

ISSN: 0974-8946
Vol. 47, Issue. 04: 2022

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ISSN: 0974-8946
Vol. 47, Issue. 04: 2022

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ISSN: 0974-8946
Vol. 47, Issue. 04: 2022

Demographic	**Study group**		**Chi-square**	**p-value**
	Group A (N=18) Mean ± SD	**Group B (N=18)** Mean ± SD		
Age (Years) [a]	69.06±3.28	69.44±3.36	-	0.7277
Gender [b]				
Male	7(38.89%)	4(22.22%)	1.1782	0.2781
Female	11(61.11%)	14(77.78%)		
Height (CM) [a]	155.51±16.27	158.30±13.96	-	0.5847
Weight (Kg) [a]	56.38±9.12	65.27±10.26	-	0.0096*
BMI (Kg/m^2) [a]	23.10±3.18	26.22±4.22	-	0.0173*

Table 2 :Demographic data of all participants in both the groups

ISSN: 0974-8946
Vol. 47, Issue. 04: 2022

Pain in visual analogue scale	Study Groups Mean±SD		Within the Groups p value		Between the Groups p value
	Group A	Group B	Group A	Group B	
1. Rest	0.22±0.58	0.37±0.62	0.2584	0.0007*	0.5907
2. Walking	-1.21±6.25	1.79±0.92	0.0001*	0.0001*	0.0001*
3. Ascending Stairs	0.36±0.55	1.77±1.02	0.0011*	0.0001*	0.0001*
4. Descending Stairs	0.68±0.85	2.12±0.96	0.0001*	0.0001*	0.0001*
5.Sit to Stand	0.46±1.11	1.68±1.03	0.0001*	0.0001*	0.0016*
6. Active Flexion	5.72± 5.58	9.06± 4.08	0.0001*	0.0001*	0.0486*
7. Passive Flexion	-1.61± 3.13	-3.0± 7.43	0.0011*	0.0001*	0.0397*

TABLE 3 : Comparison of group A and group B with respect to pretest and posttestfor rest,walking,ascending and descending stairs,sit to stand by Mann-Whitney U test and Independent t test and active and passive knee flexion using Mann-Whitney U

ISSN: 0974-8946
Vol. 47, Issue. 04: 2022

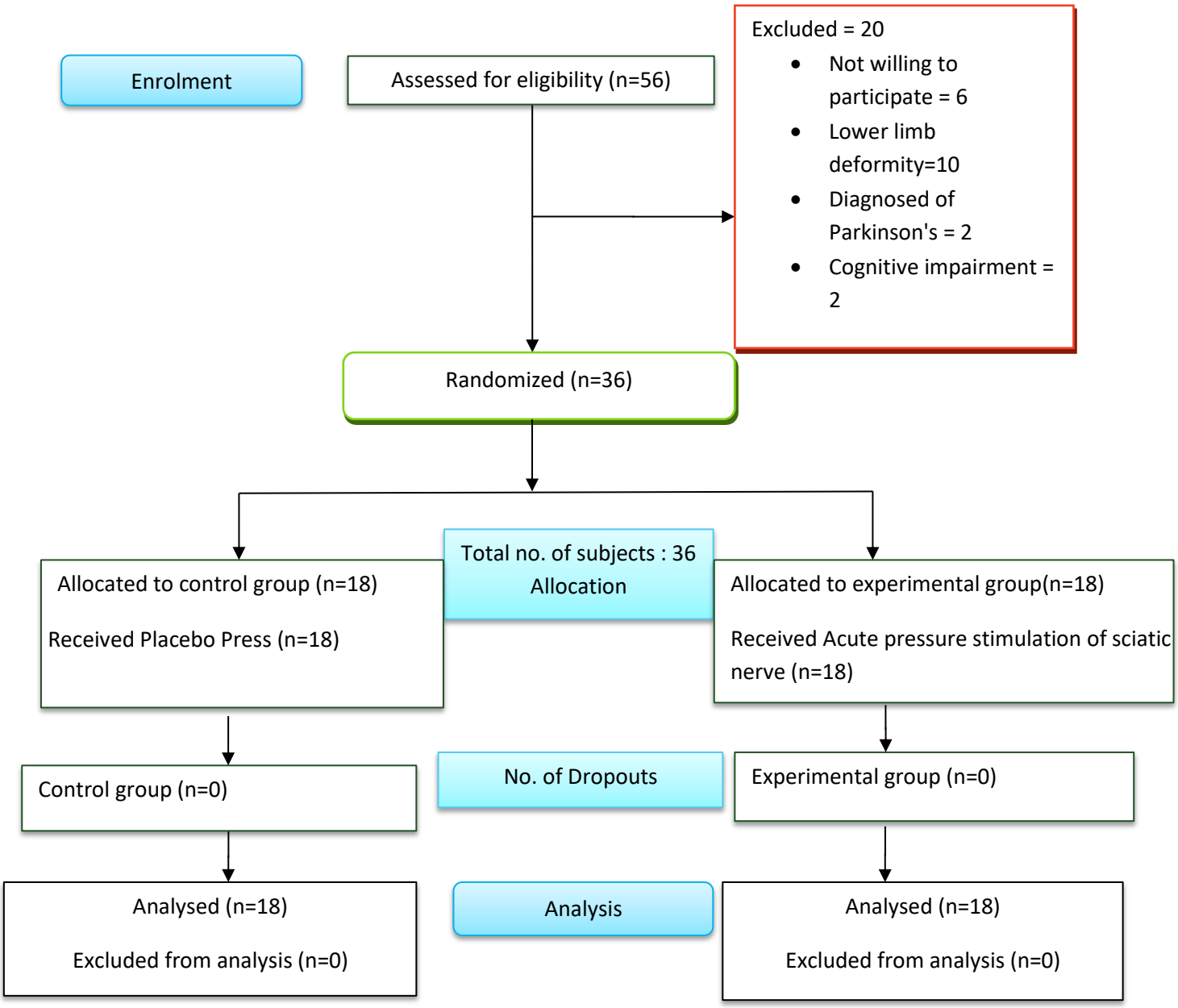

Figure 1 : CONSORT Chart