

A Comparative Study of PENS VS Shockwave Therapy on Lateral Epicondylitis in Housekeeping Staff

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ABSTRACT

Background: Lateral Epicondylitis is a pathologic condition of the wrist extensor muscles at their origin on the lateral epicondyle. Work-related musculoskeletal disorders are the most frequent health problems affecting housekeeping staff, they use uncomfortable postures, over extensions, forceful exertions, and repetitive movements over a long period of time, Lateral epicondylitis is one such condition.

Methodology: Simple random sampling was used in this comparative study, which had a sample size of 48. There were two groups, each with 24 participants: Group A (PENS) and Group B (ESWT). Pressure Algometer and Patient Rated Tennis Elbow Evaluation were primary outcome measures and Visual Analogue Scale and Goniometry were used as secondary outcome measures.

Results:

For Group A (Pens) And B (Shockwave Therapy) Regarding ROM and PRTEE Between group analysis did not Report Statistically Significant Difference ($P > 0.05$), Within Group Analysis did not report Statistically Significant difference ($P > 0.05$) in ROM and reported statistically significant difference in PRTEE. Regarding VAS and Pressure Algometer Within group analysis reported statistically significant difference ($P < 0.05$), Between group analysis Reported Statistically Significant Difference ($P < 0.05$) regarding VAS and not reported statistically significant difference ($P > 0.05$) regarding Pressure algometer. There was significant improvement seen in pain and functional disability based on VAS, PRTEE, Pressure Algometer in both groups, On comparison both group showed improvement post 6 session with statistical significance.

Conclusion: Statically both PENS and ESWT are adequate enough for abating pain, improving functional disability, improving pain pressure threshold and painless Range of motion of elbow flexion in housekeeping staff with lateral epicondylitis. Housekeeping staff have work shift of 8 hours approximately which include long hours of mopping floor and cleaning window glasses, walls, desks therefore their hand muscles are in continuous stress. Hence work place analysis, ergonomic modifications and postural correction cannot be overlooked.

Keywords- Epicondylitis, pathologic condition, Pressure Algometer

INTRODUCTION

A patho mechanical condition of the wrist extensor muscles at their origin on the lateral epicondyle is referred to as lateral epicondylitis. The location with the most biomechanical alteration is the Extensor Carpi Radialis Brevis (ECRB) tendinous origin. Additionally altered were the Extensor Digitorum Communis, Extensor Carpi Ulnaris, and Extensor Carpi Radialis longus musculotendinous tissues. Microtears and fibrosis are caused by overuse or repetitive damage in this location, and vascular ingrowth affects the tissue as angioblastic hyperplasia. In the general population, its prevalence ranges from 1 to 3%, while in occupational populations, it ranges from 2 to 23%. Its genesis results from a complex process that includes mechanical (repetitive/excessive mechanical stresses, contusions) and structural components (morphologic, cellular, metabolic)

PATHOPHYSIOLOGY: A tendon's cross-linking and collagen deposition are often increased when tension is applied to it. Tendons are easily able to stretch in response to stresses that are gradually increased. A micro-tear could happen if the force is too high for the tendon's tolerance of stretching. It is also possible to notice histological abnormalities such as angio-fibroblastic hyperplasia, which is a granulation tissue manifestation that disrupts normal collagen synthesis. Studies on the histopathology of ECRB in patients with chronic Lateral epicondylitis have revealed both necrosis and evidence of fibre regrowth. It was once believed that lateral epicondylitis was a form of tendinitis because it affects the tendon. However, histological analysis has revealed that it lacks inflammatory cells like neutrophils and macrophages. As a result, the illness is now understood to be a tendinosis, which is a degenerative process. A micro-tear occurs when the rate of stretching exceeds the tendon's tolerance, and tendinosis comes from the tendon's adaptability to numerous micro-tears.

General management includes 5 means of treatment includes to relieve pain ,inflammation, promote healing, control force loads ,improve local & general fitness.

EXTRACORPOREAL SHOCKWAVE THERAPY (ESWT) has been used to treat musculoskeletal disorders for more than ten years. It is most commonly used to treat tendinopathies caused by sports-related overuse, such as patellar tendinopathy, proximal plantar fasciitis, lateral epicondylitis, calcific or non-calcific tendonitis, and many more.

PERCUTANEOUS ELECTRICAL NERVE STIMULATOR (PENS) is a unique therapeutic method, which is considered a type of electro acupuncture in which an electric current is applied through needles readily inserted in various body sites. The needle serves as an electrode for the transmission of the current, It is variation of dry needling. PENS has been demonstrated to be a successful approach for the management of pain caused on by a variety of conditions, including postoperative pain, tension headache, migraine, neuropathic pain, and chronic low back pain..

MATERIAL, METHODOLOGY AND OUTCOME MEASURES

Study design is Experimental study, simple random sampling is used with 48 sample size Inclusion criteria was Housekeeping staff of age above 30 -60 years working from more than 1 year with VAS above 5, Tenderness on palpation and Positive Cozens test and mills test.

Exclusion criteria include history of upper limb trauma, any identified cases of local or systemic infection, cancer, neurological problems, Orthopaedic conditions or fractures, and psychiatric conditions, Open wound in arm and forearm, Hypersensitive skin.

Primary and secondary outcome measures used in this study were Pressure Algometer and PRTEE, VAS and Goniometry

PROCEDURE

After obtaining permission from Institutional Ethical Committee and registering in Clinical Trial Registry India (CTRI/2022/12/048285). Samples were recruited and Screening forms were filled with demographic data including Name, Age, Gender and inclusion exclusion criteria, Pain area was identified by palpation. Then chit method was used to randomly divide groups in two A and B.

Selected participants were than given consent forms and explanation of study was given.

- Group A was given PENS 3 sessions per week for 2 weeks.
- Group B was given ESWT 3 sessions per week for 2 weeks.

GROUP A:

□ Patients were assessed on the basis of positive COZENS and MILLS test on extensors of wrist and the area of treatment was exposed and area of pain was palpated .The procedure of PENS therapy was explained to the subjects. VAS score PRTEE score and Pain tolerance score was recorded pre-treatment 1st session and post treatment 6th session. Patients were taken in supine lying and both the needles were inserted over painful area. Electrical stimulation was passed through Dual channel pocket TENS via Alligator electrodes.



Fig. 8 Patient treated with PENS

GROUP B:

Patients were assessed on basis of positive COZENS and MILLS test on extensors of wrist and the area of treatment was exposed and area of pain was palpated .The procedure and ESWT was explained to the subjects. VAS score, PRTEE score and Pain tolerance score was recorded pre-treatment 1st session and post treatment 6th session. Patients were taken in sitting position with forearm extended and rested on a couch, on pain area of common extensor muscles gel was applied and ESWT was administered.



Fig. 9 Patient treated with ESWT

Vitamin C supplements was given prior to treatment, and Cold pack given to participants after treatment to guard against muscle soreness in both groups

PARAMETERS

PENS ⁽²⁰⁾	SHOCKWAVE THERAPY
<ul style="list-style-type: none"> • NEEDLE SIZE = 0.25×25 mm • FREQUENCY :15/30 Hz • DURATION 15 min 	PRESSURE: 1.5 -2.4 Pa, FREQUENCY-15 Hz SHOCKS -2000

STATISTICAL ANALYSIS

SPSS 26.0 (SPSS Inc., Chicago, IL) statistical package was used to analyze data and significance level set at **p<0.05**. For assessing mean and standard deviation **Descriptive statistics** was performed of the corresponding groups. Assessment of Data Normality was done by using **Shapiro Wilkison test**. Using **MANN WHITNEY U inferential statistics** difference between groups was determined. and within group analysis was done using **WILCOXON MATCHED PAIR TEST**. For checking frequency in gender **CHI SQUARE test** was used.

Table NO.1- Descriptives-GROUP WISE

		N	Minimum	Maximum	MEAN	Std. Deviation Statistic
GROUP A	ROM-PRE	24	134.000	142.000	138.20833	2.399120
	ROM-POST	24	134.000	142.000	138.62500	2.163012
	VAS-PRE	24	5.100	7.800	6.07500	.790294
	VAS-POST	24	1.100	3.200	2.01667	.572308
	PRTEE-PRE	24	22.500	69.000	37.97917	11.442179
	PRTEE-POST	24	8.000	41.000	18.54167	7.069402
	PRESSURE-PRE	24	.800	2.500	1.63750	.467009
PRESSURE-POST	24	1.900	3.900	2.86667	.485142	
GROUP B	ROM-PRE	24	130.000	141.000	137.91667	2.872912
	ROM-POST	24	130.000	141.000	138.45833	2.686183
	VAS-PRE	24	5.100	7.300	6.19583	.775987
	VAS-POST	24	1.500	3.300	2.46250	.554674
	PRTEE-PRE	24	24.000	48.500	40.43750	7.238653
	PRTEE-POST	24	8.500	27.500	16.64583	5.408285
	PRESSURE-PRE	24	.900	2.600	1.71667	.438046
PRESSURE-POST	24	1.400	3.900	2.81250	.638825	

Table No. 2- Age Distribution

*P<0.05 is statistically significant (Shapiro Wilkison test, p<0.05)

		GROUP A(PENS)	GROUP B (ShockwaveTherapy)
AGE GROUPS	30-40	14(58.4%)	14(58.4%)
	41-50	8(33.3%)	10(41.6%)
	51 +	2(8.3%)	0

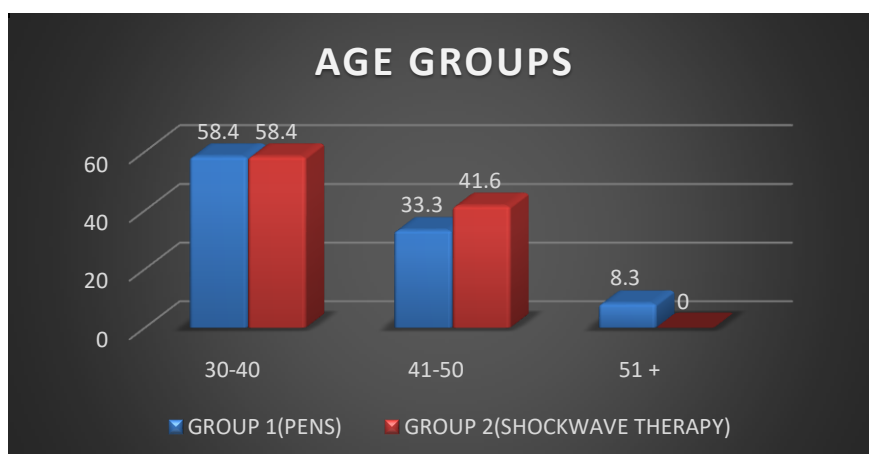


Table No. 3- Gender Distribution

*P<0.05 is statistically significant

		GROUP A(PENS)	GROUP B (Shockwave therapy)
GENDER	MALE	3	2
	FEMALE	21	22

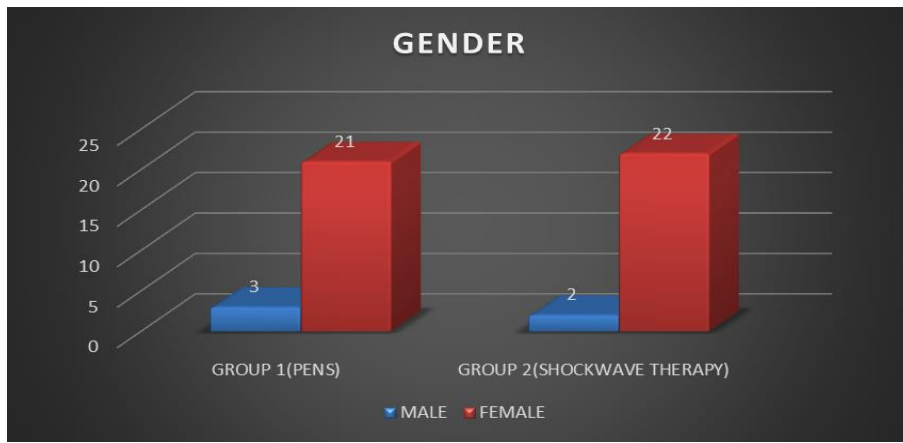


TABLE NO. 4- COMPARISON OF ROM

		GROUP A(PENS)	GROUP B(SHOCKWAVE THERAPY)	Z VALUE (MANN WHITNEY U TEST)	P VALUE
ROM	PRE	138.21±2.39	137.83±2.84	1.97	0.06
	POST	138.63±2.16	138.39±2.67	0.62	0.53
Z VALUE		0.04	1.38		
P VALUE (WILCOXON PAIR TEST)		0.87	0.17		
DIFFERENCE		0.42±0.23	0.56±0.17		

*P<0.05 is statistically significant (Shapiro Wilkinon test, p<0.05)

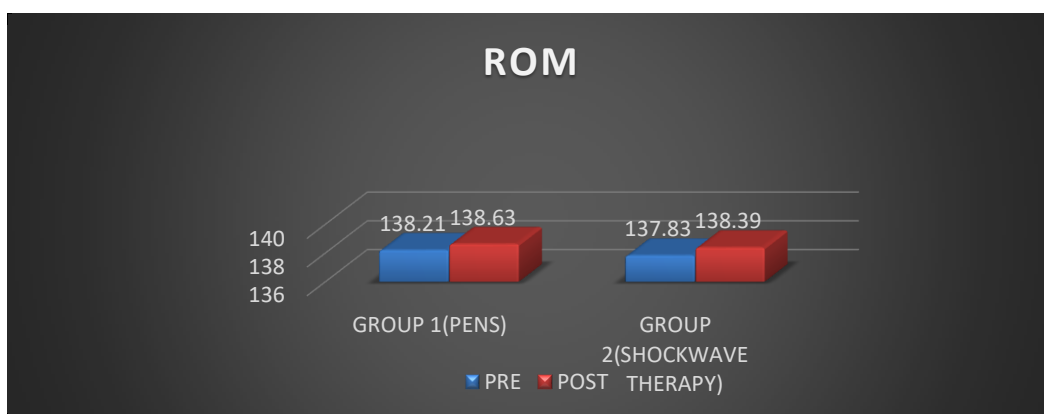


TABLE NO. 5- COMPARISON OF VAS

		GROUP A(PENS)	GROUP B(SHOCKWAVE THERAPY)	Z VALUE (MANN WHITNEY U TEST)	P VALUE
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VAS	PRE	6.07±0.78	6.29±0.75	0.99	0.32
	POST	2.01±0.56	2.49±0.55	2.99	0.004*
Z VALUE		0.0001*	0.0001*		
P VALUE (WILCOXON PAIR TEST)		20.71	20.11		
DIFFERENCE		4.06±0.22	3.8±0.20		

*P<0.05 is statistically significant (Shapiro Wilkinson test, p<0.05)

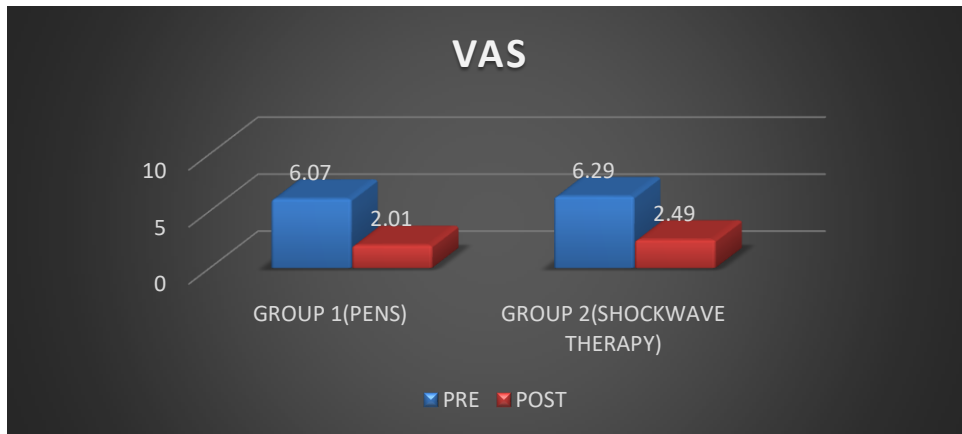


TABLE NO. 6- COMPARISON OF PRTEE

		GROUP A (PENS)	GROUP B (Shockwave therapy)	Z VALUE (MANN WHITNEY U TEST)	P VALUE
PRTEE	PRE	37.97±11.21	41.15±6.33	1.21	0.23
	POST	18.54±6.92	16.71±5.39	0.97	0.33
Z VALUE		7.25	14.54		
P VALUE (WILCOXON PAIR TEST)		0.0001*	0.0001*		
DIFFERENCE		19.43±4.29	24.44±0.94		

*P<0.05 is statistically significant (Shapiro Wilkinson test, p<0.05)

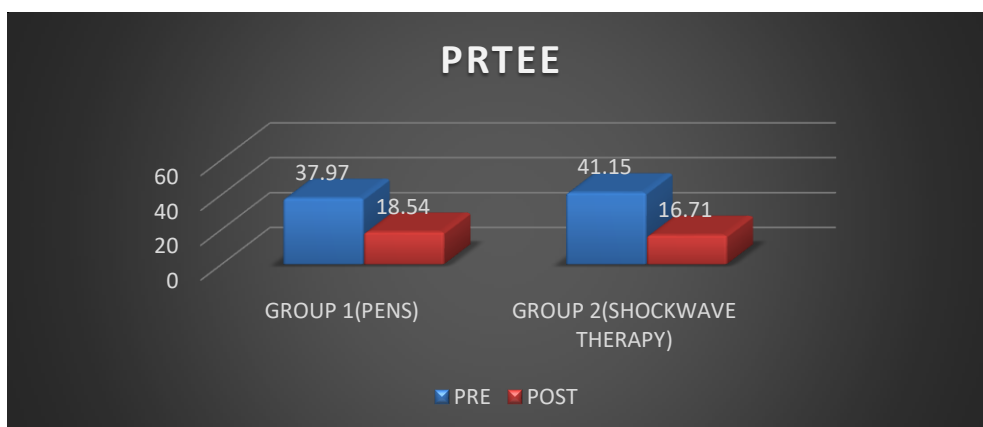
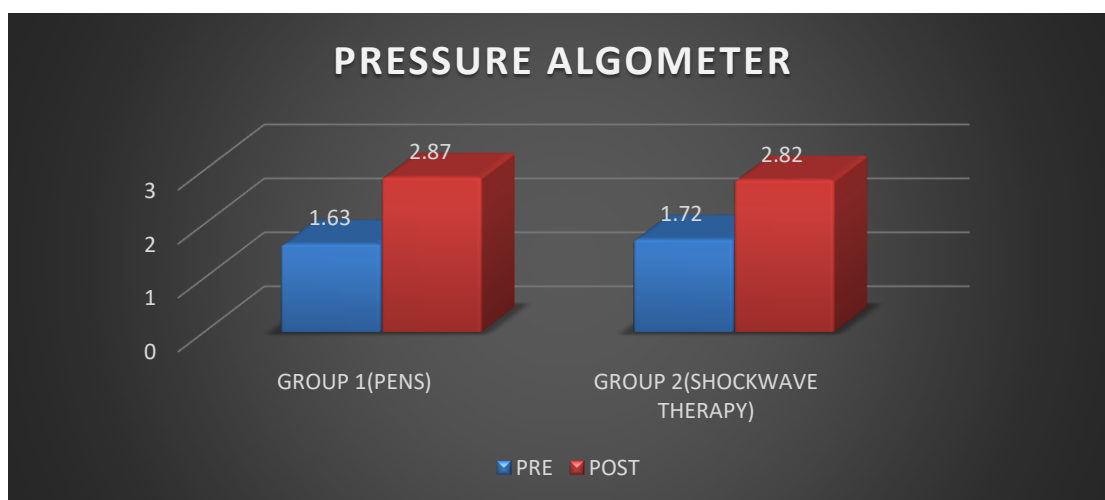


TABLE NO.7- COMPARISON OF PRESSURE ALGOMETER

		GROUP A(PENS)	GROUP B(SHOCKWAVE THERAPY)	Z VALUE (MANN WHITNEY U TEST)	P VALUE
PRESSURE ALGOMETER	PRE	1.63±0.45	1.72±0.43	0.70	0.48
	POST	2.87±0.47	2.82±0.63	0.31	0.75
Z VALUE		9.33	7.06		
P VALUE (WILCOXON PAIR TEST)		0.0001*	0.0001*		
DIFFERENCE		1.24±0.02	1.10±0.20		

*P<0.05 is statistically significant (Shapiro Wilkinson test, p<0.05)



RESULTS

- Table 1 shows Descriptive statistics which assess the mean and standard deviation of group A(PENS) and group B(SHOCKWAVE THERAPY)
- Table 2 and graph 2 represents Age-distribution, that shows 58.4% patients were in both groups between age 30-40, 33.3% and 41% were in PENS and Shockwave therapy respectively between 41-50 age and 8.3 % in PENS group above 51 age .Mean age of participants in group 1 (PENS) and group 2 (shockwave therapy) as 38.0±5.94 and 40.04±6.19 respectively Mann Whitney U test did not report statistically significant difference in mean age between the groups (p>0.05)
- Table 3 and graph 3 represents gender distribution which shows 12.5% and 8.4% male patients, 87% and 91.6% female patients in PENS and Shockwave group respectively. Gender of participants in group 1 (PENS) as Male 3(12.5%) , female 21(87.5%) and group 2(Shockwave Therapy) as Male 2(8.45%) Female 22(91.6%) respectively.
 CHI SQUARE test did not report statistically significant difference in frequency in gender between the groups(p>0.05)
 Table 4 and graph 4 represents Range of Motion. ROM Between group analysis by Mann Whitney U Test did not Report Statistically Significant difference With Respect To PRE or POST interval (P>0.05). Within Group Analysis By Wilcoxon matched pair rank test did not report Statistically Significant difference regarding both Both GROUP A & GROUP B (P>0.05).
- Table 5 and graph 5 shows comparison of Visual Analogue Scale
 Regarding VAS, Between group analysis by Mann Whitney U Test Reported Statistically Significant difference With Respect To POST interval(P<0.05). Within Group Analysis by Wilcoxon matched pair test reported Statistically Significant difference regarding both GROUP A & GROUP B (P<0.05).

5. Table 6 and graph 6 shows comparison of Patient Rated Tennis Elbow Evaluation Regarding PRTEE , Between group analysis by Mann Whitney U Test did not Report Statistically Significant Difference With Respect To PRE or POST interval($P>0.05$). Within Group Analysis by Wilcoxon Match Pair test reported Statistically Significant difference regarding both Both GROUP A & GROUP B ($P<0.05$).
6. Table 7 and graph 7 represents comparison of Pressure Algometer Regarding Pressure Algometer, Between group analysis by Mann Whitney U Test did not Report Statistically Significant Difference With Respect To PRE or POST interval ($P>0.05$). Within Group Analysis by WILCOXON MATCHED PAIR test reported Statistically Significant difference regarding both Both GROUP A & GROUP B ($P<0.05$).

DISCUSSION

The study was aimed to compare the effects of PENS and Extracorporeal Shockwave Therapy on Lateral Epicondylitis. It was an experimental study, 48 Housekeeping staff having Lateral Epicondylitis were recruited and divided into 2 groups. GROUP A was treated with Percutaneous Electrical Nerve Stimulation ($n=24$) and Group B was treated with Extracorporeal Shockwave Therapy ($n=24$)

The treatment was given for 6 days on alternative basis for 2 weeks. Patients were assessed pre-treatment (1st session) and post treatment (6th session) with Visual Analogue Scale, Pressure Algometer, Range of motion of Elbow flexion and Patient Rated Tennis Elbow Evaluation, both the groups showed improvement after the intervention individually statistically.

In our study the interventions are focused on Pain, Functional disability and Range of motion, and post treatment effects of ESWT and PENS on Lateral epicondylitis. VAS, PRTEE, Pressure Algometer are assessing pain, functional disability and pain pressure threshold and tenderness other than that Range of motion of elbow is also taken into consideration

Visual analogue scale score as shown in table 6 depicts decreased score in both groups A (PENS) and B (ESWT) when comparing to pre-treatment both have shown almost equal improvement in pain scores. The pain VAS is an unidimensional way to assess pain a person is experiencing. VAS being as subjective scale is often used widely in calibrating pain in individuals with cancer, rheumatic disorders, and chronic pain,^(1,1) in the above study PENS and ESWT showed equally beneficial in mitigating pain. PENS helps in closing the Pain Gate and also the local effects of the needle together gives analgesic effects thus decreasing the pain. Similarly ESWT application reduce substance P in the tissue treated, and reduce synthesis of it in dorsal root ganglia cells leads to long term analgesic effect.

Patient Rated Tennis Elbow Evaluation score as shown in table no.7 our study did not show statistically Significant difference (Table 7) between GroupA (PENS) & Group B(ESWT).

ESWT and PENS both modalities are equally adept in decreasing pain and improving functional disability. PRTEE have combined i.e. total score is used to assign equal weight to both pain and disability. Total scores range from 0 (no pain and functional impairment) (worst pain imaginable with a highly significant functional deficit) 100, based on the pain score total (out of 50 points) , functional subscale (for specific activities 60 points plus usual activity 40 points to give subscale out of 100 which are then divided into two to provide the remaining 50%).^(1,2)

Comparison of results of Pressure Algometer from both the groups depicted in table no.8 in which Pain Pressure Threshold was increased in both groups A (PENS) and B (ESWT) when comparing to the pre-treatment scores. They showed nearly equal improvement in post assessment. Pressure Algometer claims to be an objective measure and also subjective measure, it is based on pain reported by patient, referred or local pain location can be manually palpated but unable to measure the tenderness of such areas. Once the proper measuring site has been identified, pressure algometry can be used to analyze how delicate the tissue is ⁽²⁾.

PENS release the biochemical mediators locally- include neurotransmitters, endorphins, and enkephalin interfere with the reaction to pain by which pain is inhibited and pain pressure threshold is increased and it is similar to ESWT which works on substance P Extracorporeal shockwaves use single pressure pulse with duration of microsecond i.e. focused at précised site guided by ultrasound to reduce pain and increase pain tolerance by stimulating angiogenesis and regeneration of micro-vessels⁽³⁾

MECHANISMS OF ACTION OF ESWT

Extracorporeal Shock Wave Therapy is a non-invasive safe and well tolerable physical therapy modality has been reported to exert various therapeutic effects. Extracorporeal shockwave therapy has shown to improve symptoms of lateral epicondylitis.

Lateral epicondylitis has a degenerative pathophysiology. ESWT has a stimulating influence on cell proliferation, and enhancement of the healing process, ESWT may be able to speed up tendon healing, according to the morphological alteration, cell proliferation, and motility of treated cell, results in collagen synthesis, neovascularization, , and activation of differentiation clinical genes ⁽⁴⁾

Shockwave therapy is thought to reduce pain from insertional tendinopathy by causing neovascularization, improving blood flow to the affected area, and starting the healing process for the chronic inflammatory tissues through tissue regeneration ⁽⁵⁾

It can be roughly categorized into three categories: calcification destruction, tissue regeneration, and pain alleviation.

- **PAIN REDUCTION**

Hyper-stimulation analgesia may be the mechanism via which ESWT relieves pain. Signal transmission to the brainstem would be reduced if the treated location were overstimulated. Animal studies demonstrate that ESWT affects Pain transmission by working on substance-P, calcitonin gene-related peptide (CGRP) release in the dorsal root ganglia and neurovascular sprouting .

- **REGENERATION OF TISSUES**

Another hypothesis holds that ESWT promotes tissue regeneration. The mechano transduction model, in which mechanical strain on the cytoskeleton results in cell responses and enhanced protein synthesis, does fit tissue regeneration using ESWT. Healthy human tenocytes produced more type-I collagen and grew more cells in response to ESWT.

In affected human tenocytes ESWT reduced the expression of interleukins (ILs) and matrix Metalloproteinases (MMPs), which are linked to tendinopathy. Animal studies demonstrate that ESWT increases collagen synthesis and matrix turnover, bone-tendon junction vascularization, and tissue regeneration in ischemia and wound healing.

- **CALCIFICATION DESTRUCTION**

It's hypothesized that ESWT cause calcifications destruction from tendons. This is similar to how shockwaves are employed in lithotripsy to eliminate kidney stones. In vivo studies demonstrate that ESWT causes the calcifications disintegration of shoulder tendinopathy ⁽⁶⁾

PENS MECHANISM OF ACTION

PENS – A combination of Pocket TENS and dry needle both causes rapid local vasodilatation and increase blood flow which is result of the micro-trauma caused by needling, which aid in the healing and analgesic processes. For days until the minor wound heals, injury potentials are generated, and they can last and continue to stimulate. Prostaglandins are produced as a result of this stimulation, which raises vascular permeability. Mast cell destruction leads to the release of histamine and heparin, which dilates the blood vessels. Improvement in perfusion and alleviation of muscle spasm brought on by localized needling and somato-visceral reflexes reduce pain ⁽⁷⁾

Although there are numerous theories, it is thought that PENS and TENS share the same mechanism of action. The two primary hypotheses are:

1. First depends on the regulation of A-beta fibres (The Gate control theory). In order to block the transmission of pain, Percutaneous Electrical Nerve Stimulation generates an electrical field which hyperpolarizes c-fibers and stops action potentials from spreading down the pain fibers i.e. of small diameter at the spinal cord level.
2. As shown by (PET) positron emission tomography, it stimulate descending pain modulatory pathway on cortical & subcortical structures and in primary somatosensory cortex, insular cortex anterior cingulate cortex,, Antero-ventral insula it increases cerebral blood flow.^(8,9)

Studies showing similar effects as decreasing pain and increasing functional abilities in acute and chronic cases by shockwave are : Rompe et al. hypothesized that 3 times per week treatments using, Plantar fasciitis appeared to respond well to 1000 low-energy shockwave impulses of 0.06 mJ/mm, with significant pain alleviation and functional improvement⁽⁵⁾ Extracorporeal shock wave therapy lessens the amount of discomfort and enhance everyday activities in those who have recently diagnosed with tennis elbow⁽¹⁰⁾

The study by Frank A. Pettrone shows without the use of local anesthesia, Extracorporeal Shock Wave therapy is a secure and efficient method of treating chronic Lateral Epicondylitis in people who have not responded to traditional lateral epicondylitis treatment .The subjective impression of the disease stage, the functional and pain scores can all be greatly improved by shock wave therapy⁽¹¹⁾

There are various benefits to using the needles as electrodes as opposed to more conventional transcutaneous nerve stimulation (TENS). In addition to removing the skin's resistance to electrical currents, multiple studies found that PENS was effective at relieving sciatica & chronic LBP pain and improving their functional abilities^(12,13,14) And also some articles have concluded that PENS can decrease pain intensity but not related disability in musculoskeletal pain disorders.⁽¹⁵⁾ Debra K. Weiner et.al concluded that PENS decreases pain and self-reported pain associated disability improves. Study was done on chronic low back pain in older adults⁽¹⁶⁾

TABLE 5: GONIOMETRY –RANGE OF MOTION OF ELBOW FLEXION

In goniometry for elbow flexion no statistically significant difference in ranges were observed in housekeeping staff with Lateral Epicondylitis, Range of motion was nearly full but painful pre-treatment (1st day) and Range of motion was pain free after treatment (6th session) in both Group A (PENS) as well as Group B (ESWT) which indicate that ESWT and PENS both worked well in mitigating pain in range of motion.

Clinically, patients were more satisfied with the ESWT than PENS because ESWT is a non-invasive method and PENS is invasive method, minor bruising, inflammation and pain flares were observed in some patients treated with PENS. Some patients were initially skeptical about the unfamiliar sound from shockwave therapy but in consecutive sittings patients got adapted and became comfortable to treatment.

CONCLUSION

It can be concluded from the above study that both PENS and ESWT are adequate enough for abating pain, improving functional disability, improving pain pressure threshold and painless range of motion of elbow flexion in housekeeping staff with lateral epicondylitis statistically. But, housekeeping staff have shift of 8 hours approximately daily which include frequently mopping of floor and cleaning window glasses, walls, desks hence their hand muscles are in continuous stress. Work place analysis and ergonomic alterations are also required so they don't suffer from same clinical manifestation again.

REFERENCES

1. Hjermsstad MJ, Fayers PM, Haugen DF, Caraceni A, Hanks GW, Loge JH, Fainsinger R, Aass N, Kaasa S, European Palliative Care Research Collaborative (EPCRC). Studies comparing numerical rating scales, verbal rating scales, and visual analogue scales for assessment of pain intensity in adults: a systematic literature review. *Journal of pain and symptom management*. 2011 Jun 1;41(6):1073-93.
2. Rompe JD, Overend TJ, MacDermid JC. Validation of the patient-rated tennis elbow evaluation questionnaire. *Journal of Hand Therapy*. 2007 Jan 1;20(1):3-11.

3. Ylinen J. Pressure algometry. *Aust J Physiother.* 2007 Jan 1;53(3):207.
4. Yoo JI, Oh MK, Chun SW, Lee SU, Lee CH. The effect of focused extracorporeal shock wave therapy on myofascial pain syndrome of trapezius: A systematic review and meta-analysis. *Medicine.* 2020 Feb;99(7).
5. Vulpiani MC, Nusca SM, Vetrano M, Ovidi S, Baldini R, Piermattei C, Ferretti A, Saraceni VM. Extracorporeal shock wave therapy vs cryoultrasound therapy in the treatment of chronic lateral epicondylitis. One year follow up study. *Muscles, Ligaments and Tendons Journal.* 2015 Jul;5(3):167.
6. d'Agostino MC, Craig K, Tibalt E, Respizzi S. Shock wave as biological therapeutic tool: From mechanical stimulation to recovery and healing, through mechanotransduction. *International journal of surgery.* 2015 Dec 1;24:147-53
7. van der Worp H, van den Akker-Scheek I, Van Schie H, Zwerver J. ESWT for tendinopathy: technology and clinical implications. *Knee Surgery, Sports Traumatology, Arthroscopy.* 2013 Jun;21:1451-8.
8. Basu S, Palekar TJ, Baxi G, Palekar PJ, Deshpande M. Comparative Study of Percutaneous Electrical Nerve Stimulation versus Transcutaneous Electrical Nerve Stimulation on Trigger Points in Levator Scapulae Muscle. *Journal of Coastal Life Medicine.* 2023 Jan 27;11:177-89.
9. Lin T, Gargya A, Singh H, Sivanesan E, Gulati A. Mechanism of peripheral nerve stimulation in chronic pain. *Pain Medicine.* 2020 Aug;21(Supplement_1):S6-12.
10. Strand NH, D'Souza R, Wie C, Covington S, Maita M, Freeman J, Maloney J. Mechanism of action of peripheral nerve stimulation. *Current Pain and Headache Reports.* 2021 Jul;25:1-9.
11. Razavipour M, Azar MS, Kariminasab MH, Gaffari S, Fazli M. The short term effects of shock-wave therapy for tennis elbow: a clinical trial study. *Acta Informatica Medica.* 2018;26(1):54.
12. Pettrone FA, McCall BR. Extracorporeal shock wave therapy without local anesthesia for chronic lateral epicondylitis. *JBJS.* 2005 Jun 1;87(6):1297-304.
13. Dommerholt J, Bron C, Franssen J. Myofascial trigger points: an evidence-informed review. *Journal of Manual & Manipulative Therapy.* 2006;14(4):203–221
14. Ghoname EA, Craig WF, White PF, Ahmed HE, Hamza MA, Henderson BN, Gajraj NM, Huber PJ, Gatchel RJ. Percutaneous electrical nerve stimulation for low back pain: A randomized crossover study. *JAMA.* 1999;281:818–82
15. Ghoname EA, White PF, Ahmed HE, Hamza MA, Craig WF, Noe CE. Percutaneous electrical nerve stimulation: An alternative to TENS in the management of sciatica. *Pain.* 1999;83:193–199
16. Plaza-Manzano G, Gómez-Chiguano GF, Cleland JA, Arías-Buría JL, Fernández-de-las-Peñas C, Navarro-Santana MJ. Effectiveness of percutaneous electrical nerve stimulation for musculoskeletal pain: A systematic review and meta-analysis. *European Journal of Pain.* 2020 Jul;24(6):1023-44.
17. Weiner DK, Perera S, Rudy TE, Glick RM, Shenoy S, Delitto A. Efficacy of percutaneous electrical nerve stimulation and therapeutic exercise for older adults with chronic low back pain: a randomized controlled trial. *Pain.* 2008 Nov 30;140(2):344-57.