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A Study on Effectiveness of Artificial-Intelligence Assisted Extracorporeal Shockwave Therapy (ESWT) Dosage and Physiotherapist-Planned ESWT Dosage on Patients with Low Back Pain-An Experimental Study

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ABSTRACT

Objective: To evaluate the effectiveness of AI planned ESWT dosage compared to physiotherapist dosage in terms of reducing pain, minimizing disability experienced and improving health-related quality of life for chronic low back pain patients. Methodology: The ethical clearance was obtained from AUHEC (AUHEC/MPT-FT-002/17/02/2025). 52 participants with chronic low back pain were included in the study. The control group received the ESWT dosage planned by the physiotherapist while the intervention group received the ESWT dosage planned by ChatGPT. The participants received the ESWT dosage 3 times a week for 4 weeks. Results: Both groups did show significant improvement ($p<0.05$) VAS, ODI, and QoL after receiving the ESWT treatment. However, there is no significant difference ($p>0.05$) in comparison within the improvement of VAS, ODI and QoL after receiving the ESWT dosage. Conclusion: AI was not inferior to physiotherapist in ESWT dosage planning; ESWT was beneficial for low back pain patients

KEYWORDS: Artificial Intelligence; Extracorporeal Shockwave Therapy; Physical Therapy Modalities; Low Back Pain

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INTRODUCTION

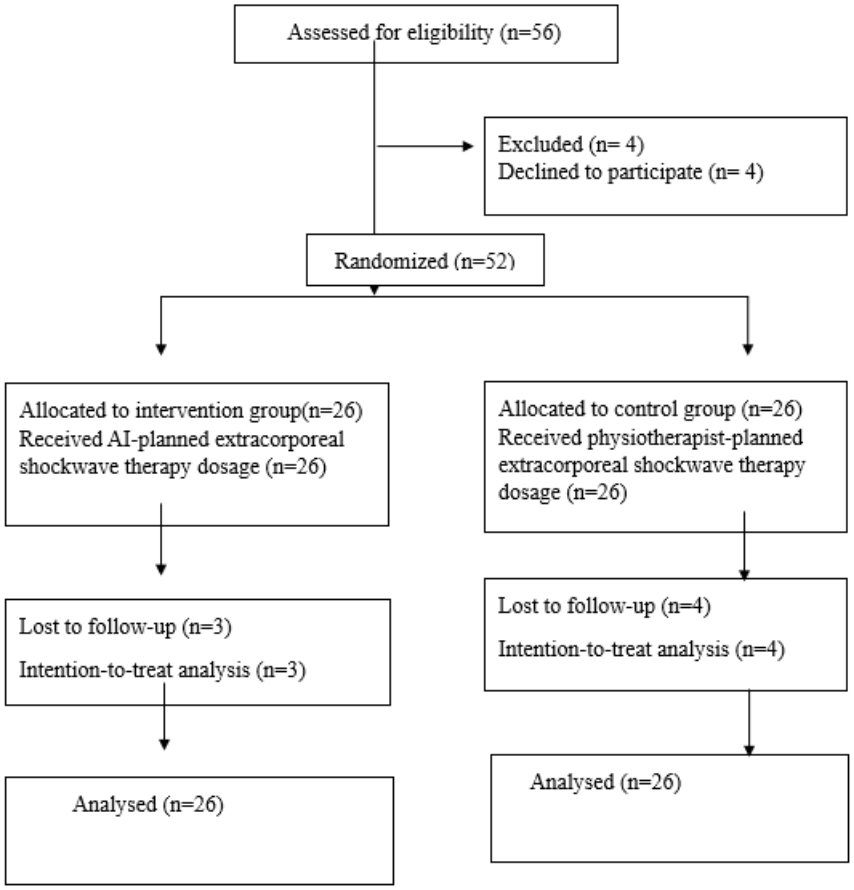
Artificial Intelligence (AI) is a transformative, revolutionary area of computer science which makes it possible for machines to carry out tasks that normally call for human cognitive ability. Among various subset of AI model, the large language model (LLM) had gained significant popularity in recent years. One of the most prominent examples is ChatGPT, an AI-powered chatbot that leverages LLMs and deep learning algorithms, has gained its recent popularity due to its ability to generate human-like responses. This rapid rise in popularity can be attributed to its ability to engage in meaningful and coherent conversations across various domains, making it widely adopted in sectors such as customer service, education, and healthcare. (Beck et al., 2024; Dave et al., 2023) As a generative AI model, ChatGPT synthesizes large electronic datasets to produce coherent, contextually relevant human like response and conversation, whereby through synthesizing the electronic dataset, it produces or generate a response that seemed accurate and convincing for the asked question. (Dass & Packham, 2023). In the healthcare setting, there is an increasing global burden of healthcare challenges including work efficiency, staff shortages, rising costs, aging populations, and pandemic-related crises. Thus, in response, the usage of AI has appeared as a potential tool to migrate certain challenges faced, hence enhancing the overall efficiency in the healthcare sector. AI has demonstrated its significant potential in transforming healthcare delivery by becoming a valuable tool for its expanding work on has enhancing medical efficiency where it enhances clinical decision making, workflow optimization, allocation of resources, alleviating certain workloads, detection and diagnosis of diseases, analysis of optimum treatment, prediction of possible prognoses and tailoring a more personalized care for patients. Ultimately, these advancements contribute to a more efficient and effective healthcare system. This benefit of implementing AI into the healthcare sector had been reflected onto the AI-driven healthcare market, expanding its market value which is projected to reach an estimated value of US$67.4 billion by 2029, with an annual growth rate of 48%. (Derakhshanian et al., 2024). Physiotherapy, like other healthcare disciplines, stands to benefit significantly from the advancement of AI and its innovations, including assessments and treatment plans. (Veras et al., 2024) The job of a physiotherapist involves providing a relevant rehabilitation assessment hence allow the designation of a tailored, suitable and personalized treatment plan for the patients of various conditions. However, these processes of assessment and treatment designation was highly dependent on the physiotherapist's experiences, moreover the performance of processes was difficult due to presence of the time frame and manpower constraint. Therefore, the utilization of AI-based systems in rehabilitation practice is expanding rapidly to help physiotherapists whereby it can support rehabilitation assessments, facilitate a more effective personalized treatment plans, and improve adherence to therapeutic exercises. The concept of AI was able to aid with both training and monitoring to the patient through either a virtual (informatics-based) or physical (robotics-based) methods in physiotherapy practices. (Alsobhi et al., 2022) Extracorporeal shockwave therapy (ESWT) is a form of non-invasive therapeutic approach that involves the application of

acoustic waves to targeted areas of the body through the skin. ESWT was initially introduced in 1982 as a treatment for lithotripsy. ESWT has since gained significant popularity in musculoskeletal rehabilitation due to its minimal invasiveness, cost-effectiveness, short treatment duration, and negligible complications. These advantages have contributed to its widespread use in the management of various musculoskeletal conditions, particularly those associated with chronic pain, delayed bone healing, and soft tissue injuries. Among the conditions successfully treated with ESWT are plantar fasciitis, epicondylitis, tendinitis, delayed bone union, and myofascial pain syndromes. Studies have reported high success rates in alleviating pain and enhancing functional recovery using ESWT (De la Corte-Rodríguez et al., 2023; Yue et al., 2021). A variety of physiotherapeutic interventions have been proven effective in managing low back pain. (Tikhile & Patil, 2024) Among these, extracorporeal shockwave therapy (ESWT) has demonstrated significant therapeutic benefits. Despite substantial evidence supporting ESWT's effectiveness in treating low back pain, it has received relatively less attention in clinical applications. One possible reason for this limited use is the lack of standardization and inconsistency in the ESWT dosage across various studies. Previous research has reported wide variations in ESWT dosage, ranging from 400 to 4000 shocks per application, with frequency settings between 8Hz and 16Hz and pressure applications ranging from 1.5 to 3 bar. (Wu et al., 2023; Fan et al., 2022; Kızıltaş et al., 2022; Guo et al., 2021; Lange et al., 2021; Eftekharsadat et al., 2020; Walewicz et al., 2019) Such inconsistencies in dosage protocols could impact treatment efficacy and contribute to variability in patient outcomes. To address this issue, this study proposes to investigate the effectiveness of AI-planned ESWT dosage compared to physiotherapist-planned ESWT dosage for the treatment of chronic low back pain under the following aspects, pain reduction, disability minimization and quality of life enhancement.

METHODOLOGY

Ethical clearance was obtained from the AIMST University Human Ethical Council (AUHEC) (application reference number: AUHEC/MPT-FT-002/17/02/2025. The procedure was being explained to patients prior to they participated in the study and informed consent form was being signed by both participants and investigators when the participant agreed to participate in the study. Then the participants were randomly distributed into both groups without knowing which groups they were fall into. The study was carried out at a AIMST Physiotherapy Clinic, located at AIMST University, Bedong, Kedah, Malaysia. The study was conducted for 6 months, from December 2024 till May 2025. The participants received the from 3 sessions per week of treatment for duration of 4 weeks. The outcome measurement was taken before the first session start and was collected at the last session. The sampling of studies was obtained as 52 after considering effect size of shockwave was large effect size (d=0.8) with the reference from the study by Eftekharsadat et al. (2020). The inclusion criteria for the sample were patients who were aged from 18 to 65 who had experienced low back pain for more than 3 months and within 12 months, came with primary diagnosis of low back pain, and who agreed to participate in the studies. Meanwhile, patients who were contraindicated from ESWT, including active infection, malignancy, pregnancy, coagulopathy were excluded from the study. The ESWT was applied with the patients were instructed to position themselves in prone lying with the applicator head positioned over the area of maximum pain in the lumbar and sacral spine, using a contact method with a labile movement to cover the painful region effectively. A standard ultrasound gel was used as a coupling medium to reduce tissue resistance and facilitate proper energy transmission. The treatment would focus on the lumbar and sacral regions, particularly around the pain region or other trigger points identified by the patient. The skin is being exposed, the optimal contact between the applicator and skin is ensured with the use of ultrasound gel which is essential for effective treatment. (Walewicz et al., 2019) The intervention group received ESWT dosage from Chat-GPT 4 (by Open AI, free access version). The question that was set for the Chat-GPT 4 was based on the following criteria: Gender, Age, Duration of pain, Pain site (specific to reach region with left and right and spine number as bony marking), Presence of radicular Symptom (with which dermatome), Reflexes (Hypo or Hyper reflexia of patellar and achilles tendon), presence of trigger point, muscle bulk status (spasm or loss), body built, VAS score, ODI score, SF-36 score. The dosage was planned in the terms of pressure bar, frequency, number of shocks. While the control group received ESWT dosage from the physiotherapist who had been performed ESWT for more than 3 years in their clinical pratice. The physiotherapist decided the ESWT dosage based on the clinical decision on their patient and described the dosage as with pressure bar, frequency, and number shocks. The ESWT used was DolorClast® Radial Shock Waves by Electro Medical Systems (EMS) (Switzerland). The outcome measurement taken include visual analog scale (VAS) for pain measurement, Oswestry Disability Index (ODI) for disability measurement, and 36-Item Short Form Survey (SF-36) for health-related quality of life measurement. The statistical tools used was IBM SPSS Statistics (version 25.0) The descriptive statistics of both gender and age would be first describe. The comparison within outcome of both intervention group and control group before receiving first ESWT therapy and after receiving the last ESWT therapy was analysed through Wilcoxon-Singed Ranked Test. The comparison within the difference of the outcomes among intervention group and control group was done through Mann-Whitney U test.

RESULT



The study included a total of 52 participants, comprising 21 females and 31 males. Participants were evenly distributed between the intervention group (26 participants: 9 females, 17 males) and the control group (26 participants: 12 females, 14 males), ensuring a balanced representation of gender across groups. The mean age of participants of the intervention group was 42.42 years (±14.89), while the mean age of participants of the control group was 40.08 years (±12.09). Both groups did show significant improvement in the outcomes. The VAS score in intervention group decreased from 6 (3 to 8) at baseline to 3 (0 to 8) post-treatment with p-value <0.05. The median ODI score in intervention group decreased from 41 (16 to 58) at baseline to 19 (0 to 58) post-treatment and Wilcoxon-Signed ranked test showed p-value <0.05. The median SF-36 score in the intervention group improved from 47 (24 to 78) at baseline to 80 (34 to 96) post-treatment with Wilcoxon-Signed ranked test showed p-value <0.05. The median VAS score of the control group decreased from 6 (3 to 8) at baseline to 3 (0 to 5) post-treatment with Wilcoxon-Signed ranked test showed p-value <0.05. The median ODI score of control group decreased from 37 (13 to 66) at baseline to 18 (0 to 54) post-treatment with Wilcoxon-Signed ranked test showed p-value <0.05. The median SF-36 score of control group increased from 40.50 (15 to 78) at baseline to 77 (38 to 97) post-treatment with Wilcoxon-Signed ranked test showed p-value <0.05. However, between the improvement in the outcome in both groups, are not significant. The VAS score of participants in the intervention group showed a median reduction of 3 points (0 to 6), whereas the participants in the control group showed a median reduction of 3 points (0 to 7), the Mann-Whitney U test showed a p-value of 0.603. The ODI score of participants in the intervention group showed a median reduction of 16 points (0 to 43), whereas the participants in the control group showed a median reduction of 17.50 points (0 to 52), the Mann-Whitney U test showed a p-value of 0.679. Lastly, the SF-36 score for the participants in the intervention group showed a median improvement of 25.5 points (0 to 58), while the participants in the control group showed a median improvement of 34.50 points (0 to 59), the Mann-Whitney U test showed a p-value of 0.607.

DISCUSSION

Through the statistically significant in the improvement for participants after receiving the ESWT treatment, our result did show that ESWT was effective in reducing pain, reduce disability experienced and improving health-related quality of life for patients who suffering low back pain. Previous systematic review and meta-analysis involving 632 patients concluded that ESWT significantly contributes to pain reduction in individuals with chronic low back pain (Liu et al., 2023) The pain relief effect of ESWT towards chronic musculoskeletal condition was believed able to achieve through its biological, neural and mechanical mechanisms. (De la Corte-Rodríguez et al., 2023) Previous literature has established a strong positive relationship within the pain intensity experienced and the disability experienced by individuals, which highlights that individuals experiencing higher pain intensity would tend to suffer from more severe disability (Harahap et al., 2021). Therefore, the participants in our study which had reduction in pain after receiving the treatment did also show a reduction in disability experienced. In terms of the interaction between pain intensity experienced, disability experience, and impact towards quality of life, previous study had shown a successful reduction of pain intensity, could cause improvement of physical function, hence causing reduction of disability

experienced, and enhancement of quality of life was achieved through the intervention of pain education for low back pain individuals. The literature study on implementation of pain education interventions for chronic low back pain have demonstrated that reductions in pain intensity and disability correlate with improvements in overall well-being (Sidiq et al., 2024). Besides, the statistical not significant in the comparison between the outcome of both groups did show that AI was not inferior to physiotherapist in planning ESWT dosage for patient with chronic low back pain. This result also had shown that the potential usage of AI in dosage planning for ESWT and others physiotherapy modalities and might provide the same effect as physiotherapist as well. This indeed had made the potential of integrating AI into physiotherapy practice to assist physiotherapist for a more accurate dosage planning of ESWT and other modalities.

CONCLUSION

The study did shows AI was not inferior to physiotherapist in designing dosage for ESWT for chronic low back pain patients. Besides, the study did also show that ESWT was an effective treatment modality for patients who suffering with chronic low back pain. Future research could work on AI designing dosage for other therapeutic modalities and overcome the addressed limitations of the study.

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