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A COMPARATIVE STUDY OF PHYSIOTHERAPY OUTCOMES BETWEEN INFRARED-TENS COMBINATION AND PNF THERAPIES IN NPH PATIENTS

STUDI PERBANDINGAN HASIL FISIOTERAPI ANTARA KOMBINASI TERAPI INFRARED-TENS DAN PNF PADA PASIEN HNP

Sri Lestari Ramadhani Nasution [1], Ermi Girsang [2*], Siti Aminah [1*]

[1] *Department of Hospital Management, Universitas Prima Indonesia, Pekanbaru, Indonesia*
[2] *Department of Health Environment, Universitas Prima Indonesia, Pekanbaru, Indonesia*

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A B S T R A C T

Background: *The pain experienced by Nucleus Pulposus Herniation (NPH) patients can have an impact on productivity and may lead to disability. Therefore, non-pharmacological therapies can serve as alternatives in reducing pain levels for Grade I and Grade II NPH patients.* ***Purpose:*** *To compare the difference in effectiveness between Infrared-Transcutaneous Electrical Nerve Stimulation (IR-TENS) combination and Proprioceptive Neuromuscular Facilitation (PNF) therapies in reducing pain among NPH patients.* ***Method:*** *This research employed a quasi-experimental design with a two group before and after intervention conducted at the Physical Medicine and Rehabilitation Unit of Royal Prima Hospital in Medan. A total of 20 NPH patients were provided with interventions, consisting of a combination of IR and TENS therapies for 10 patients, and PNF therapy for the other 10 patients, administered eight times for one month. Pain measurement was conducted using a Visual Analogue Scale (VAS) questionnaire before and after the interventions. The statistical analysis employed an Independent Sample T test, with a significance level (α) set at 0.05.* ***Result:*** *There was a reduction in moderate and severe pain scales in both groups, and no subjects were experiencing severe pain anymore. However, the reduction in moderate pain scale was higher in the group receiving the combination of infrared and TENS therapies (80%) compared to the PNF therapy (70%). The Independent T test showed that there was no significant difference between the effectiveness of the combination of IR-TENS therapies and PNF therapy on pain in NPH patients (p-value = 0.075).* ***Conclusion:*** *Both groups of patients experienced a reduction in pain scale after the interventions, although there was no significant difference in the outcome between the two treatment groups. This implies that both therapies are equally effective in suppressing pain in NPH patients.*

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Correspondence:
Ermi Girsang
Siti Aminah

E-mail :
ermigirsang@unprimdn.ac.id
sitiaminahya1109@gmail.com

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A B S T R A K

Latar belakang: Nyeri yang dialami oleh pasien *Hernia Nukleus Pulposus* (HNP) dapat berdampak pada produktivitas dan dapat berujung pada kelumpuhan. Oleh karena itu, terapi non-farmakologis dapat menjadi alternatif dalam menurunkan skala nyeri pada pasien *Proprioceptive Neuromuscular Facilitation (PNF)* Grade I dan Grade II. **Tujuan:** Membandingkan perbedaan keefektifan antara kombinasi terapi IR-TENS dan PNF dalam mengurangi nyeri pada pasien HNP. **Metode:** Penelitian ini menggunakan desain penelitian quasi dengan rancangan *two* group sebelum dan sesudah interevensi yang dilaksanakan di Instalasi Rehabilitasi Medik (Fisioterapi) Rumah Sakit Royal Prima Medan. Sebanyak 20 pasien HNP diberikan intervensi berupa terapi kombinasi IR dan TENS untuk 10 pasien, serta terapi PNF untuk 10 pasien lainnya, yang diberikan sebanyak 8 kali selama satu bulan. Pengukuran nyeri dilakukan menggunakan kuesioner *Visual Analogue Scale (VAS)* sebelum dan setelah intervensi. Uji statistik yang digunakan adalah *Independent Sample T* tes, dengan tingkat kepercayaan (α) yang ditetapkan sebesar 0.05. **Hasil:** Terlihat adanya penurunan skala nyeri sedang dan berat pada masing-masing kelompok, dan tidak ada lagi subjek yang menderita nyeri pada skala berat. Namun, penurunan skala nyeri sedang lebih banyak pada subjek yang mendapatkan terapi kombinasi infrared dan TENS (80%) dibandingkan dengan terapi PNF (70%). Uji *Independent T* tes menunjukkan tidak ada perbedaan yang signifikan antara kelompok yang diberi terapi kombinasi IR-TENS dan terapi PNF terhadap nyeri pada pasien HNP (*p-value* = 0.075). **Kesimpulan:** Pasien pada kedua kelompok perlakuan sama-sama mengalami penurunan skala nyeri setelah adanya intervensi, meskipun tidak terdapat perbedaan hasil yang signifikan antara kedua kelompok perlakuan. Hal ini menunjukkan bahwa kedua terapi tersebut sama efektifnya dalam menekan nyeri pada pasien HNP.

Kata kunci:
HNP, Terapi penurunan skala nyeri, Fisioterapi

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INTRODUCTION

Low Back Pain (LBP) is a common musculoskeletal issue that occurs worldwide and is estimated to be one of the most prevalent complaints experienced by 80% of the global population (Urits *et al*., 2019). The Basic Health Research of 2018 reported the prevalence of musculoskeletal diseases in Indonesia to be 7.3% (Agency for Health Research and Development, 2020). One of the diseases frequently encountered in lower back pain is *Nucleus Pulposus Herniation* (NPH), characterized by clinical symptoms such as lower back pain radiating to the lower extremities or even extending to the toes. If the condition worsens, it can lead to paralysis (Dydyk *et al*., 2024; Schroeder *et al*., 2016). NPH is a medical condition where the cushion or intervertebral disc protrudes and compresses the spinal nerve fibers, causing lower back pain that predominantly occurs between the L4 and L5 vertebrae. Part or the entire nucleus pulposus protrudes toward the spinal canal (De Decker and Fenn, 2018).

Several literature sources identify risk factors for NPH, including older age, smoking habits, *Body Mass Index* (BMI), and occupation (workload, working positions, repetition, and duration) (Sørensen *et al*., 2011; Ahsan *et al*., 2013; Billy *et al*., 2014; Citko *et al*., 2018; Lan *et al*., 2016; Li *et al*., 2020; Nordberg *et al*., 2021; Siccoli *et al*., 2022). Previous literature reports that the treatment of NPH with severe pain intensity can be managed through interventions such as nerve root steroid injections or even surgery. However, many NPH patients can reduce their pain through conservative treatments such as analgesics, epidural injections, and physical therapies like traction, ultrasound, and low-level laser therapy (Alentado *et al*., 2014; Altun and Yüksel, 2017; Benoist, 2002; Suri *et al*., 2012; Unlu *et al*., 2008). Indeed, non-pharmacological therapies can also be employed to reduce pain in NPH patients, such as *Transcutaneous Electrical Nerve Stimulation* (TENS), ultrasound, *infrared* (IR) therapy, interferential therapy, short-wave diathermy, lumbar traction, McKenzie exercises, core stability exercises, and *Proprioceptive Neuromuscular Facilitation* (PNF) (Chou *et al*., 2016; Barreto and Lin, 2017; Gao *et al*., 2022). In this research, the researchers selected three types of physiotherapy modalities to be applied to NPH patients, namely a combination of IR and TENS therapies, as well as PNF therapy.

Infrared (IR) therapy is a physical therapy modality that involves electromagnetic radiation with light rays that produce a heating effect when absorbed by the skin. The heat emitted by infrared has been shown to enhance tissue extensibility, aid in improving joint range of motion, reduce pain sensation, and promote the healing of soft tissue lesions (Anekwu, 2015; Ojeniweh *et al*., 2019). TENS is an electrical stimulation method used to stimulate the posterior horn nerve cells and produce a sedative effect (American Physical Therapy Association, 2000). This method has been proven effective in reducing pain, alleviating clinical symptoms, and regulating peripheral oxygen radical levels. Additionally, it helps prevent oxidative damage to cardiac muscle tissue (Unterrainer *et al*., 2010; Wang *et al*., 2018). In addition to being cost-effective and easy to learn, TENS has a low risk of hazards, including toxicity or other side effects (Gladwell *et al*., 2015; Jauregui *et al*., 2016; Teoli and An, 2023). The PNF therapy is utilized to elicit neuromuscular responses by facilitating proprioceptors. PNF can stimulate proprioceptors in muscles and joints around the waist region, which may be beneficial in enhancing sensorimotor regulation and balance performance. This therapy has been shown to be quite effective in reducing pain (Kofotolis and Kellis, 2006; Westwater-Wood *et al*., 2010; Young *et al*., 2015; Areeudomwong *et al*., 2017).

Based on the preliminary survey conducted at the Medical Record Installation of Royal Prima Hospital in Medan, the number of visits by NPH patients with complaints of lower back pain was recorded to be 50 patients per month from January to December 2022. The objective of this research was to compare the effectiveness of a combination of IR and TENS therapies, as well as PNF therapy in reducing pain among NPH patients.

MATERIAL AND METHOD

This research has obtained ethical approval from the Research Ethics Committee of Universitas Prima Indonesia with registration number: 070/KEPK/UNPRI/VII/2023. This research employed a quasi-experimental design with a two group before and after intervention. The research was conducted at the Medical Rehabilitation Installation (Physiotherapy) of Royal Prima Hospital in Medan from January to May 2023. The average number of *Nucleus Pulposus Herniation* (NPH) patients accessing physiotherapy services ranged from 8 to 10 individuals per day, totaling approximately 160 patients in a month. The sample for the research was determined using a purposive sampling technique, with 20 patients meeting the inclusion criteria.

The inclusion criteria for the subjects in this research included NPH patients with Grade I and Grade II, experiencing chronic pain for the last 3 - 6 months, aged between 30 to 75 years, capable of understanding

given instructions, willing to participate in the combined therapy program of IR-TENS and PNF for eight sessions, and not currently undergoing any other therapy programs. Subjects not included in the research were those with impaired consciousness, patients scheduled for surgery due to ruptured bulging disc or osteoporosis and infection, NPH patients contraindicated for PNF therapy due to tumors, cysts, or cancer, and NPH patients receiving other pain-reducing treatments, including oral medications, from the 20 patients who met the inclusion criteria, the researchers divided them into two groups. Group 1 consisted of 10 subjects who received a combination of IR therapy and TENS, while Group 2 included 10 subjects who were given PNF therapy.

The intervention in this research involved providing pain therapy using IR, TENS, and PNF to treat pain in the subjects. Infrared therapy was administered by applying superficial heating to the treated skin area for 20 minutes, inducing various physiological effects necessary for healing. On the other hand, TENS was a therapy that employed an electrical system and was applied for 20 minutes to stimulate the nervous system through the skin's surface, resulting in analgesic effects. TENS has been found to be an effective tool for modulating pain. As depicted in Figure 2, the combination therapy of IR and TENS was conducted by physiotherapists during the patients' hospital visits, with a total of eight intervention sessions (twice a week) over one month.

Proprioceptive Neuromuscular Facilitation (PNF) therapy was carried out independently by the patients at home for 45 minutes per session. PNF therapy can be carried out independently, as patients can utilize a mirror to correctly align their body during the treatment. The patients were requested to undergo PNF therapy a total of eight times (twice a week) for one month. Before the therapy, the subjects were given education by a physiotherapist regarding the movements in PNF therapy to help them repeat the movements at home, as shown in Figure 3. The researcher kept a close eye on the patient through video calls to ensure that the patient followed the schedule and instructions. PNF, in this context, is a therapeutic exercise using a mirror and focuses on moving the unaffected body parts. The application of mirror exercises aims to enhance the strength and functional abilities of paralumbal muscles. In addition, in the absence of a clinical instructor to guide the patient in carrying out PNF therapy, mirror exercises can help correct posture in a symmetrical position during the therapy.

The instrument used was the *Visual Analogue Scale* (VAS), designed to measure pain intensity. VAS is the most commonly used tool to assess pain, as it presents a linear scale visually depicting the gradations of pain levels a patient might experience. The pain range is represented as a 10 cm line and pain severity is classified into score ranges can be seen in Figure 1. Scores of 1 - 3 indicate mild pain, scores of 4 - 6 represent moderate pain, scores of 7 - 9 signify severe pain, and a score of 10 indicates very severe pain. After the physiotherapist explained the pain scale to the patient, the patients were asked to indicate the number corresponding to their pain intensity.

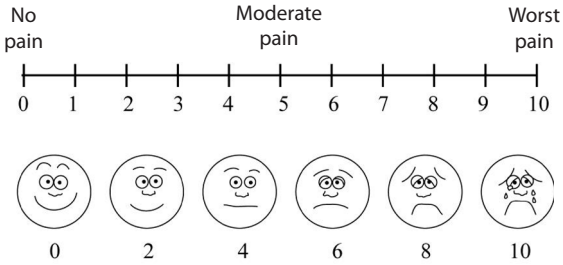

Figure 1. Pain levels based on the *Visual Analogue Scale* (VAS)

Before the intervention, subjects in Group 1 and Group 2 were asked to determine their pain levels using the VAS while performing specific movements, such as sitting to standing. After receiving education about the therapy they would undergo for one month, both Groups 1 and 2 began their respective interventions from the first week to the fourth week. Subsequently, subjects in both groups filled out the VAS questionnaire again to measure the pain experienced after the intervention. The gathered data were then analyzed using both univariate and bivariate analysis. Univariate analysis involved describing the sociodemographic characteristics and VAS scores. Subsequently, bivariate analysis was conducted to assess the differences in pain levels before and after the intervention. The statistical test employed for this purpose was the *Independent Sample T* test with a significance level (α) set at 0.05.

Figure 2. Combination therapy of Infrared (IR) and *Transcutaneous Electrical Nerve Stimulation* (TENS)

Figure 3. Education of movement *Proprioceptive Neuromuscular Facilitation* (PNF) therapy

RESULT

The characteristics of *Nucleus Pulposus Herniation* (NPH) patients are presented in Table 1. A total of 20 subjects participated in this research, with the majority aged between 50 - 55 years (50%). The research included an equal number of male and female subjects. Most of the respondents had a diploma level education (50%). Based on occupation, the highest number of subjects worked as employees (25%) and nurses (25%).

Next, pain scale measurements were conducted on both groups before the interventions were given, as shown in Table 2. In Group 1, the data revealed that nine subjects (90.0%) reported experiencing moderate pain, while one subject (10.0%) reported severe pain. Regarding Group 2, nine subjects (90.0%) reported moderate pain, while one subject (10.0%) reported severe pain.

After the intervention, there was a decrease in moderate and severe pain scales in both groups, and no subjects experienced severe pain anymore, as shown in Table 2. However, the reduction in moderate pain scale was slightly significant in the group receiving the combination of infrared-TENS therapies (80%) compared to the PNF therapy (70%).

Table 3 shows that the average pain intensity score in Group 1 before receiving infrared + TENS therapy was 1.90 (SD = 0.316), and the average pain intensity score after the therapy was 1.80 (SD = 0.422). The average difference before and after the treatment was 0.1 (SD = 0.106). Meanwhile, the average pain intensity score in Group 2 before receiving PNF therapy was 1.90 (SD = 0.316), and the average pain intensity score after the therapy was 1.70 (SD = 0.483). The average difference before and after PNF therapy was 0.1 (SD = 0.167). Thus, it can be stated that the combination therapy of infrared and TENS is slightly effective in reducing pain intensity in patients with NPH. However, the results of the *Independent T* test indicate that there was no significant difference between infrared + TENS therapies and PNF therapy in reducing pain in NPH patients (*p-value* = 0.075). This result shows there was no significant difference of pain reduction in both treatment groups (*p-value* > 0.05), even though both therapies are equally effective in suppressing pain in NPH patients.

Table 1. The characteristics of *Nucleus Pulposus Herniation* (NPH) patients (n = 20)

Characteristics	Category	n (%)
Age (years)	41 - 45	6 (30)
	50 - 55	10 (50)
	60 - 65	4 (20)
Gender	Male	10 (50)
	Female	10 (50)
Education level	Senior high	6 (30)
	Diploma	10 (50)
	Bachelor	4 (20)
Occupation	Housewife	2 (10)
	Employee	5 (25)
	Technician	3 (15)
	Nurse	5 (25)
	Midwife	1 (5)
	Teacher	3 (15)
	Retired civil servant	1 (5)

Table 2. The pain scale in Group 1 and Group 2 before and after the intervention

Pain scale	Before intervention		After intervention	
	Infrared + TENS (Group 1) n (%)	PNF (Group 2) n (%)	Infrared + TENS (Group 1) n (%)	PNF (Group 2) n (%)
No pain	-	-	-	-
Mild pain	-	-	8 (80)	7 (70)
Moderate pain	9 (90)	9 (90)	2 (20)	3 (30)
Severe pain	1 (10)	1 (10)	-	-

Note: *Transcutaneous Electrical Nerve Stimulation* (TENS); *Proprioceptive Neuromuscular Facilitation* (PNF)

Table 3. The results of the mean comparison of treatment outcomes in *Nucleus Pulposus Herniation* (NPH) patients

Group	Mean	SD	*p-value*
Infrared + TENS (Group 1)			
Before intervention	1.90	0.316	0.075
After intervention	1.80	0.422	
Difference	0.1	0.106	
PNF (Group 2)			
Before intervention	1.90	0.316	0.075
After intervention	1.70	0.483	
Difference	0.1	0.167	

Note: *Transcutaneous Electrical Nerve Stimulation* (TENS); *Proprioceptive Neuromuscular Facilitation* (PNF)

DISCUSSION

The *Nucleus Pulposus Herniation* (NPH) patients involved in this research ranged in age from 41 to 65 years. Existing literature mentioned that the majority of NPH patients are typically between 30 and 50 years old (Cicco and Willhuber, 2022). Similar findings were reported by Ikhsanawati *et al*. (2015), where the majority of NPH patients in their study were 51- 60 years old. In our research, there was no significant difference in the proportion of patients based on gender. However, previous studies have observed a higher prevalence of NPH more common in males (Ikhsanawati *et al*., 2015; Cicco and Willhuber, 2022) with Iqbal *et al*. (2015) noting a higher prevalence in males.

Based on educational level, the sample in this research was dominated by patients with a higher education/university background. While there are no specific studies examining this aspect, NPH has been linked to occupation type in previous research. According to a study by Abid *et al*. (2021), occupations such as those of an educator, office worker, or any job involving prolonged sitting, bending, and weight lifting have been found to increase the likelihood of developing herniated lumbar disc nucleus pulposus.

This research focuses on comparing several types of physiotherapy modalities aimed at reducing pain in NPH patients. The lumbar region is the largest area that bears the load when the body moves and supports body weight, considering both anatomical and functional aspects. Consequently, the spine is highly susceptible to injuries or damage, leading to frequent impairments and reducing the quality of life for individuals (Tanderi *et al*., 2017). The first group received physiotherapy using a combination of IR and TENS therapies, while the second group was given PNF therapy. The results of the analysis show that subjects in both groups experienced a reduction in pain. However, the reduction in the pain scale was slightly significant in the first group. In other words, the combination of the two therapies was effective in reducing pain intensity in NPH patients in this research. Previous studies have reported that physical modalities in treating patients, such as TENS, infrared, and PNF, increased joint range of motion and contributed to the improvement of lumbar function experienced by NPH patients (Dwi *et al*., 2020; Ginting and Susilo, 2022; Hasesa, 2022). There are not many studies discussing the comparison of TENS and infrared combination therapies in NPH patients, but their effectiveness in reducing pain has been evaluated in other diseases. A study reported that the combination of TENS and infrared therapies is more recommended than stand-alone therapy for rehabilitation. Infrared therapy alone is less effective in reducing the pain intensity scale calculated by the VAS pain severity, both before and after therapy (Barolla *et al*., 2021).

The administration of TENS, which stimulates sensory nerves, in managing lumbar pain caused by NPH operates through the "Gate Control Theory" mechanism with the concept of an analgesic response. This theory involves stimulating A-beta sensory fibers, which close the gate in the spinal medulla, effectively blocking pain impulses carried by A-delta and C sensory fibers. This stimulation occurs in the dorsal column of the vertebral column, specifically at the region with pressure on the disc or facet, causing the sensation of pain (Pop *et al*., 2010; Wang *et al*., 2018). The IR therapy, conducted by directly heating the skin, has the capability to alter the viscoelastic properties of the irradiated tissues, thereby increasing the extensibility of the lumbar connective tissues, including muscles and skin (Ansari *et al*., 2014). Previous studies have also reported the effectiveness of IR therapy and no side effects were found in the subjects (Gale *et al*., 2006).

Proprioceptive Neuromuscular Facilitation (PNF) therapy is effective in increasing the activity of the paraspinal muscles, thereby improving the stability of the lumbar spine in both static and dynamic conditions. This improvement can contribute to the reduction of back pain intensity in patients (Areeudomwong *et al*., 2017). However, a challenge faced in this research is the patient's ability to comprehend each movement

and their compliance in performing the therapy independently. The selection of the PNF method aims to improve muscle strength, *Range of Motion* (ROM), and coordination, similar to the selective rehabilitation of movement learning and strengthening through repetitions (Hindle *et al*., 2012). Furthermore, PNF techniques can reduce tension in the quadratus lumborum and piriformis muscles. The reduction in tension of the piriformis muscle can alleviate irritation on the branches of the sciatic nerve, leading to a progressive reduction in ischialgia pain. PNF is one of the effective methods used to achieve maximal muscle stretching due to its passive stretching of the tense muscles (Budiono, 2016). The improvement in muscle strength, flexibility, and reduction of muscle tension can lead to a decrease in pain and an increase in functional ability for patients (Gordon and Bloxham, 2016).

CONCLUSION

The research has demonstrated that there is no significant difference in the reduction of pain between the administration of IR-TENS combination and PNF therapies for NPH patients (*p-value* = 0.075). However, the reduction in pain intensity was more substantial in the group receiving the combined IR-TENS intervention (80%) compared to the group receiving PNF therapy (70%). Despite the lack of statistical significance, the observed trend suggests that the combination of IR and TENS therapies may have a more beneficial effect in reducing pain intensity for NPH patients when compared to PNF therapy.

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