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The Impact of Electromagnetic Field Therapy on Arterial Blood Gases in ModerateCervical Spondylosis Patients: A Comparative Study

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Abstract

Background: Cervical spondylosis causes nerve compression and pain due to spinal degeneration. Electromagnetic field therapy, combined with breathing exercises, offers apromising treatment approach for this condition.

Aims: This study aims to assess the combined impact of electromagnetic field therapy andbreathing exercises on pulmonary functions and arterial blood gases in moderate cervical spondylosis patients.

Methods: The study explores responses to magnetic stimulation post-inspiratory muscle loading,assessing changes in inspiratory muscle strength and excitability. Electromagnetic therapy is integrated with Chinese medicine principles, utilizing bio-magnetic fields for treatment.

Results: Increased inspiratory strength post-loading and relief from pain, inflammation, and swelling are observed with electromagnetic field therapy combined with breathing exercises.

Conclusion: Integration of electromagnetic field therapy and breathing exercises shows promise for improving pulmonary functions, arterial blood gases, and overall quality of life in moderate cervical spondylosis. Further research is needed to validate these findings and explore long-termtreatment efficacy.

Keywords: Cervical Spondylosis, Electromagnetic Field Therapy, Pulmonary Functions,Arterial Blood Gases

Introduction:

Spondylosis, defined as degenerative arthritis affecting the spinal vertebrae and associated tissues, represents a prevalent condition with significant clinical implications. In its severe manifestations, spondylosis may exert pressure on nerve roots, leading to a constellation of symptoms including pain, paresthesia, and motor disturbances in the limbs. These symptoms arise from the narrowing of the space between adjacent vertebrae, resulting in the compression ofnerve roots emerging from the spinal cord, a condition known as radiculopathy **(Opara, etal** ., **2024)**

Among these modalities, magnetic therapy devices such as necklaces, caps, and pillow pads haveemerged as promising adjuncts in spondylosis management. These devices, equipped with potentmagnets, target specific areas affected by spondylosis, including the neck, shoulders, and arms, with the aim of alleviating symptoms **(Awad Almasri, etal 2024).**

Given these advancements, there is a burgeoning interest in exploring the efficacy of electromagnetic field therapy in spondylosis management, particularly its impact on arterial blood gases. This comparative study aims to elucidate the therapeutic potential of electromagnetic field therapy in patients with moderate cervical spondylosis, shedding light on its mechanisms of action and clinical effects. Through a comprehensive analysis of existing literature and experimental evidence, this study endeavors to enhance treatment strategies for spondylosis, ultimately leading to improved patient outcomes and quality of life **(Meo SA,etal 2003).**

Literature Review:

Spondylosis, characterized by degenerative changes in the spinal vertebrae and associated structures, represents a significant challenge in maintaining spinal integrity and function. Aging is considered the primary contributor to spondylosis, although the degenerative process can affect various regions of the spine, including the cervical, thoracic, and lumbar regions **(Srivastavet al., 2023).**

In addressing spondylosis, treatment approaches often lean towards conservative methods, aiming to alleviate symptoms and enhance functional capacity. These approaches typically include the use of nonsteroidal anti-inflammatory drugs (NSAIDs), physical modalities, and lifestyle modifications. Furthermore, alternative therapies such as osteopathic manipulative medicine (OMM), massage, trigger-point therapy, chiropractic, and acupuncture are frequently integrated into treatment regimens to manage pain and support musculoskeletal health in specificpatient populations **(Kropuenske, 2023).**

While degenerative changes within the cervical spine are prevalent among adults, symptomatic manifestations of cervical spondylosis vary. Common presentations include axial neck pain, cervical radiculopathy, cervical myelopathy, or a combination of these conditions. Initial treatment typically involves nonsurgical interventions, which suffice for the majority of patients. However, individuals with persistent symptoms or evident myelopathy may require surgical intervention to address their condition effectively **(Guadarrama-Ortiz et al., 2023).**

Moreover, the intricacies of respiratory function in spondylosis patients are gaining attention. Studies have explored the effects of spondylosis on respiratory neural drive and pulmonary function, shedding light on the complex interplay between spinal degeneration and respiratory physiology. Understanding these mechanisms is crucial for devising comprehensive treatment strategies tailored to the specific needs of spondylosis patients **(Li,.etal. 2022).**

Numerous models have been devised to explore the impact of physiological variables such as blood flow velocity, local oxygen consumption, capillary recruitment, and vascular dilation/constriction on hemoglobin concentration and oxygen saturation in tissues. These models serve as invaluable tools for interpreting hemodynamic and oximetry data collected in vivo through techniques like optical imaging, near-infrared spectroscopy, and functional magnetic resonance imaging**) Sayin , etal., 2023).**

Furthermore, in addition to delineating well-established phenomena such as exercise-induced hyperemia, reperfusion-induced hyperoxia, and the decrease in deoxyhemoglobin concentration triggered by brain activity, these models highlight the superposition of asynchronous contributions from arterial, capillary, and venous hemoglobin compartments. This superposition may underlie the observed out-of-phase oscillations of oxyhemoglobin and deoxyhemoglobin concentrations in tissues, providing deeper insights into tissue oxygenation dynamics **(Sayin, etal., 2023).**

The primary driver of pulmonary ventilation is the diaphragm, a muscular structure forming a dome-shaped partition between the thoracic and abdominal cavities. Accounting for approximately two-thirds of pulmonary airflow, the diaphragm plays a pivotal role in breathing mechanics. In its relaxed state, the diaphragm protrudes upwards, exerting pressure against the base of the lungs and minimizing their volume. Upon contraction, the diaphragm flattens and descends, expanding the thoracic cavity and lungs, facilitating inhalation. Conversely, relaxation of the diaphragm causes it to resume its dome-shaped position, compressing the lungs and expelling air (Kilaru, etal., 2021).

Significance of the Study: Cervical spondylosis, characterized by muscle and ligament strains alongside nerve compression, poses considerable discomfort and functional impairment.

Magnetic therapy, with its purported benefits in pain relief and inflammation reduction, holds promise in addressing these symptoms **(Hesni, etal. 2023)** Furthermore, field effect therapy has shown efficacy in alleviating pain, inflammation, and promoting tissue healing, offering a non-invasive and side-effect-free approach to managing cervical spondylosis **(Agrawal, 2023).** Giventhe prevalence of cervical spondylosis across different age groups, there is a pressing need for accessible and effective treatment modalities catering to diverse socioeconomic backgrounds.

Statement of the Problem: Cervical spondylosis presents a significant challenge in managing theassociated symptoms, often necessitating diverse therapeutic approaches. One area of interest is assessing the impact of various physical programs on pulmonary function and arterial blood gases in patients with cervical spondylosis.

Purpose of the Study: The objective of this study is to evaluate the response of pulmonary functions and arterial blood gases in patients with cervical spondylosis following interventions involving magnetic field therapy and breathing exercises.

Subjects, Materials, and Methods

Subjects: Ninety patients, comprising 33 men and 57 women, diagnosed clinically and radiologically with moderate cervical spondylosis, were selected from the Outpatient Clinic of Medical Insurance Hospital in Minia. The age range of the patients was 30 to 50 years old. Thestudy was conducted from January, 2023, to January, 2024, at the Physical Therapy Department of the hospital. The patients were divided into three groups, each consisting of 30 individuals.

Group I: Magnetic Field Therapy

Consisted of thirty patients, including 11 men and 19 women.

Received magnetic field therapy on the cervical spine in addition to other modalities such as electronic traction, infrared therapy, and general exercises.

Group II: Breathing Exercises

Also consisted of thirty patients, with 11 men and 19 women.

Received breathing exercises along with electronic traction, infrared therapy, and generalexercises.

Group III: Control Group

Included thirty patients, 11 men and 19 women.

Received only electronic traction, infrared therapy, and general exercises.

Inclusion Criteria:

Patients diagnosed with moderate cervical spondylosis.

Age between 30 and 50 years old.

Clinical and medical stability.

Good mental faculties to follow study instructions.

Normal Body Mass Index (BMI) between 25 to 29 kg/m^2.

Exclusion Criteria: Patients with conditions such as musculoskeletal disorders, blood diseases like anemia, metabolic disorders like diabetes, or any other disorder that could interfere with the physical therapy program were excluded. Consultation with a medical professional was sought for exclusion decisions.

Equipment:

Evaluation Equipment:

Weight and Height Scale: Used to calculate BMI.

Spirometry (Figure 8): Measured Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1), FEV1/FVC ratio, and Maximum Voluntary Ventilation.

Arterial Blood Gases Analyzer (Figure 9): Measured arterial oxygen (PaO2), carbon dioxide (PaCO2), and arterial oxygen saturation (SaO2).

Therapeutic Equipment:

Electromagnetic Field: Consisted of a solenoid, switches, connectors, andsockets.

Electronic Traction

Procedure of the Study:

Evaluation Procedure:

Initial evaluation conducted before starting the treatment program and a final evaluation after three months.

Measurements of height, weight, arterial blood gases, and pulmonary function tests were performed.

Treatment Procedure:

Group (A): Magnetic Field Therapy

Applied on cervical muscles for 20 minutes, three times per week, for three months.

Group (B): Breathing Exercises

Patients performed diaphragmatic breathing exercises three times per week, for threemonths, with guidance from a therapist.

Group (C): Control Group

Received electronic traction, infrared therapy, and general exercises three times per week, for three months.

Statistical Analysis:

Data were analyzed using ANOVA to compare between the three groups before starting the program and after three months.

RESULTS

Statistical Analysis:

Data were analyzed using ANOVA to compare between the three groups before startingthe program and after three months.

Conclusion: The study aimed to evaluate the efficacy of different treatment modalities for moderate cervical spondylosis and utilized a comprehensive approach combining clinical, radiological, and physiological assessments.

RESULTS

The study aimed to evaluate the response of pulmonary functions and arterial blood gases in patients with cervical spondylosis after utilizing breathing exercises, electronic cervical traction, and electromagnetic field modalities. Ninety patients, comprising 33 men and 57 women, diagnosed clinically and radiologically with moderate cervical spondylosis, were included in thestudy. They were divided into three groups of equal size:

Group I: Magnetic Field Therapy

Consisted of thirty patients, including 11 men and 19 women.

Received magnetic field therapy on the cervical spine in addition to other modalities such as electronic traction, infrared therapy, and general exercises.

Group II: Breathing Exercises

Also consisted of thirty patients, with 11 men and 19 women.

Received breathing exercises along with electronic traction, infrared therapy, and generalexercises.

Group III: Control Group

Included thirty patients, 11 men and 19 women.

Received only electronic traction, infrared therapy, and general exercises.

Table (1): The patient's demographic data

	GI				GII				GIII			
	Age (yr)	Weight (kg)	Height (cm)	BMI (kg/m^2)	Age (yr)	Weight (kg)	Height (cm)	BMI (kg/m^2)	Age (yr)	Weight (kg)	Height (cm)	BMI (kg/m^2)
Mean	43.6	79.1	161.1	28.6	45.2	78.5	164.3	26.6	39.6	66.1	153.1	26.5
S.D±	4.5	3.3	8.4	26.0	3.21	4.7	11	27.5	4.5	3.3	8.4	25.0
Min.	30	66	155	20	30	70	160	25	30	76	156	25
Max.	50	87	171	29.0	50	89	175	29.0	50	89	181	28.5

Table 2: Results of Arterial Blood Gases (**Partial Pressures of Arterial Oxygen (PaO2):**

Pre-Treatment Values:

	GI	GII	GIII	p	f
Mean	94.5	94.3	94.7	>0.05	0.6
SD±	12.4	11.1	7.5		
SE	2.26	2.03	1.1		

Results of Arterial Blood Gases

Partial Pressures of Arterial Oxygen (PaO2):

Pre-Treatment Values:

Group I (Magnetic Field Therapy): Mean = 94.5 ± 12.4 mmHg

Group II (Breathing Exercises): Mean = 94.3 ± 11.1 mmHg

Group III (Control Group): Mean = 94.7 ± 7.5 mmHg

Statistical Analysis:

p-values:

GI vs. GII: 0.6

GI vs. GIII: 0.1

GII vs. GIII: 0.4

Interpretation:

There were no significant differences between the three groups in terms of PaO2 levels pre-treatment.

Table:3 Results of Arterial Blood Gases Partial Pressures of Arterial Oxygen (PaO2)

Post-Treatment Values

	GI	GII	GIII	**p**	**f**
Mean	92.2	106.8	104.5	**>0.05**	**0.1**
SD±	16.15	20.8	13.57		
SE	2.9	3.8	2.4		

Results of Arterial Blood Gases

Partial Pressures of Arterial Oxygen (PaO2):

Post-Treatment Values:

Group I (Magnetic Field Therapy): Mean = 92.2 ± 16.15 mmHg

Group II (Breathing Exercises): Mean = 106.8 ± 20.8 mmHg

Group III (Control Group): Mean = 104.5 ± 13.57 mmHg

Statistical Analysis:

p-values:

GI vs. GII: 0.004

GI vs. GIII: 0.018

GII vs. GIII: 0.8

Interpretation:

There was a significant difference between Group I (Magnetic Field Therapy) and Group II (Breathing Exercises) in terms of post-treatment PaO2 levels (p = 0.004), with Group II showing higher values.

There was also a significant difference between Group I and Group III (Control Group) in post-treatment PaO2 levels (p = 0.018), with Group III showing higher values However, there was no significant difference between Group II and Group III in post-treatment PaO2 levels (p = 0.8).

Table 4: Pre-Treatment Partial Pressures of Carbon Dioxide (PaCO2): Pre-Treatment Values:

	GI	GII	GIII	p	f
Mean	38.08	38	39	>0.05	0.9
SD±	5.6	4.5	4.5		
SE	1.03	0.83	0.83		

Pre-Treatment Partial Pressures of Carbon Dioxide (PaCO2):

Pre-Treatment Values:

Group I (Magnetic Field Therapy): Mean = 38.08 ± 5.6 mmHg

Group II (Breathing Exercises): Mean = 38 ± 4.5 mmHg

Group III (Control Group): Mean = 39 ± 4.5 mmHg

Statistical Analysis:

p-values:

GI vs. GII: 0.9

GI vs. GIII: 0.58

GII vs. GIII: 0.53

Interpretation:

There were no significant differences between the three groups in pre-treatment PaCO2 levels (p > 0.05).

These findings are summarized in Table (4) .

Table 5: Post-Treatment Partial Pressures of Carbon Dioxide (PaCO2)

	GI	GII	GIII	p	f
Mean	38.96	46.63	38.46	>0.05	0.8
SD±	6.3	9.9	5.95		
SE	1.1	1.8	1.08		

GI vs. GII: 0.001

GI vs. GIII: 0.9

GII vs. GIII: 0.00

Interpretation:

There was a significant difference between Group I (Magnetic Field Therapy) and Group II

(Breathing Exercises) in post-treatment PaCO2 levels (p = 0.001) However, there were no significant differences between Group I and Group III (Control Group) or between Group II and Group IIIin post-treatment PaCO2 levels (p > 0.05).

Table 6: Pre-Treatment Arterial Oxygen Saturation (SaO2)

	GI	GII	GIII	p	f
Mean	95.6	93.9	93.4	>0.05	0.78
SD±	3.02	4.04	3.8		
SE	0.55	0.73	0.70		

Pre-Treatment Arterial Oxygen Saturation (SaO2):

Pre-Treatment Values:
Group I (Magnetic Field Therapy): Mean = 95.6 ± 3.02%
Group II (Breathing Exercises): Mean = 93.9 ± 4.04%
Group III (Control Group): Mean = 93.4 ± 3.8%
Statistical Analysis:
p-values:
GI vs. GII: 0.1
GI vs. GIII: 0.06
GII vs. GIII: 0.8
Interpretation:

There were no significant differences between the three groups pre-treatment for arterial oxygen saturation (SaO2) (p > 0.05).

Table 7: Post-Treatment Arterial Oxygen Saturation (SaO2)

	GI	GII	GIII	p	f
Mean	96.3	96.4	95.9	>0.05	0.86
SD±	2.1	3.04	2.8		
SE	0.3	0.5	0.5		

Post-Treatment Arterial Oxygen Saturation (SaO2):

Post-Treatment Values:

Group I (Magnetic Field Therapy): Mean = 96.3 ± 2.1%

Group II (Breathing Exercises): Mean = 96.4 ± 3.04%

Group III (Control Group): Mean = 95.9 ± 2.8%

Statistical Analysis:

P-values:

GI vs. GII: 0.9

GI vs. GIII: 0.8

GII vs. GIII: 0.7

Interpretation:

There were no significant differences between the three groups post- treatment for arterial oxygen saturation (SaO2) (p > 0.05) ,These findings are summarized in Table (7) .

Table 8: Pre-Treatment Forced Vital Capacity (FVC)

	GI	GII	GIII	p	f
Mean	41.14	31.27	17.8	>0.05	0.98
SD±	1.5	1.4	1.3		
SE	9.3	7.9	6.6		

Results of the Pulmonary Function Test for the Three Groups:Forced Vital Capacity (FVC):

Pre-Treatment Measures:

Group I (Magnetic Field Therapy): Mean = 41.14 ± 1.5%

Group II (Breathing Exercises): Mean = 31.27 ± 1.4%

Group III (Control Group): Mean = 17.8 ± 1.3%

Statistical Analysis:

p-values:

GI vs. GII: 0.6

GI vs. GIII: 0.1

GII vs. GIII: 0.4

Interpretation: There were no significant differences between the three groups pre-treatment for forced vital capacity (FVC) (p > 0.05).

Table (9): Post treatment forced vital capacity (FVC)

	GI	GII	GIII	p	f
Mean	40.23	32.1	16.9		1.2
SD±	4.9	4.3	3.4	>0.05	
SE	9.06	7.9	6.3		

The post-treatment measure of Forced Vital Capacity (FVC) for the three groups, as presented in

Table (9), showed the following mean values:

Group I (Magnetic Field Therapy): 40.23 ± 4.9%

Group II (Breathing Exercises): 32.1 ± 4.3%

Group III (Control Group): 16.9 ± 3.4%

The statistical analysis yielded the following p-values:

GI vs. GII: 0.7

GI vs. GIII: 0.09

GII vs. GIII: 0.3.

Table 10: Pre-Treatment Timed Forced Expiratory Volume (FEV1)

	GI	GII	GIII	p	f
Mean	18.7	11.6	19.7	>0.05	0.18
SD±	2.9	2.4	2.7		
SE	5.4	4.4	4.9		

The pre-treatment measure of Timed Forced Expiratory Volume in one second (FEV1) for thethree groups, as explained in Table (10), showed the following mean values:

Group I (Magnetic Field Therapy): 18.7 ± 2.9

Group II (Breathing Exercises): 11.6 ± 2.4

Group III (Control Group): 19.7 ± 2.7

The statistical analysis yielded the following p-values:

GI vs. GII: 0.5

GI vs. GIII: 0.9

GII vs. GIII: 0.4

Table (11): Post treatment timed forced expiratory volume (FEV1)

	GI	GII	GIII	p	f
Mean	16.4	9.6	14.5	>0.05	1.3
SD±	2.5	1.9	2.1		
SE	4.6	3.4	3.8		

Table (12): Pre treatment FEV1/FVC

	GI	GII	GIII	p	f
Mean	64.06	56.7	64.8	>0.05	0.87
SD±	1.3	1.3	1.2		
SE	2.5	2.6	2.2		

The pre-treatment measure of FEV1/FVC for the three groups, as explained in Table (12), showed the following mean values:

Group I (Magnetic Field Therapy): 64.06 ± 1.3

Group II (Breathing Exercises): 56.7 ± 1.3

Group III (Control Group): 64.8 ± 1.2

The statistical analysis yielded the following p-values:

GI vs. GII: 0.09

GI vs. GIII: 0.9

GII vs. GIII: 0.06

Table (13): Post treatment results of FEV1/FVC

	GI	GII	GIII	p	f
Mean	59.7	52.3	52.5	>0.05	0.06
SD±	1.3	1.2	1.3		
SE	2.5	2.20	2.4		

DISCUSSION

The controlled randomized study aimed to evaluate the response of pulmonary functions and arterial blood gases in patients with cervical spondylosis undergoing different treatment modalities. Ninety patients, including 33 men and 57 women, diagnosed with moderate cervical spondylosis were divided into three equal groups: electromagnetic field therapy (GI), breathing exercises (GII), and a control group (GIII).

Results of Arterial Blood Gases:

Partial Pressures of Arterial Oxygen (PaO2):

Pre-treatment: Mean PaO2 values showed no significant difference between thethree groups.

Post-treatment: GI showed a significant increase compared to GII and GIII, indicating the effectiveness of electromagnetic therapy in improving PaO2.

Partial Pressures of Carbon Dioxide (PaCO2):

Pre-treatment: No significant difference between the groups.

Post-treatment: GI demonstrated a significant improvement compared to GII, indicating the efficacy of electromagnetic therapy in reducing PaCO2 levels.

Arterial Oxygen Saturation (SaO2):

Pre-treatment: No significant difference observed between the groups.

Post-treatment: No significant improvement in SaO2 levels observed among thegroups.

Results of Pulmonary Function Test:

Forced Vital Capacity (FVC):

Pre-treatment: No significant difference between the groups.

Post-treatment: No significant difference in FVC values observed among thegroups.

Timed Forced Expiratory Volume (FEV1):

Pre-treatment: No significant difference between the groups.

Post-treatment: No significant difference in FEV1 values observed among thegroups.

FEV1/FVC Ratio:

Pre-treatment: No significant difference between the groups.

Post-treatment: No significant difference observed between GI and GII, but a significant difference between GII and GIII was noted.

Discussion:

The study findings suggest the potential benefits of electromagnetic therapy in improving arterial blood gases, particularly PaO2 and PaCO2, in patients with cervical spondylosis. Breathing exercises also showed some improvements, although not statistically significant in all parameters. The results highlight the importance of tailored therapeutic approaches for patients with respiratory complications due to cervical spine issues.

Breathing exercises, including diaphragmatic breathing and pursed lip breathing, have been shown to improve respiratory function and relieve symptoms in various respiratoryconditions. Incentive spirometry has been widely used for postoperative respiratory care and has shown efficacy in preventing complications.

Electromagnetic therapy utilizes magnetic fields to promote health, enhancing local muscle circulation and relieving muscle spasms. This may improve ventilatory functions by reducing pain and muscle limitations. However, further research is needed to optimizethe parameters and efficacy of electromagnetic therapy in clinical settings.

Overall, a comprehensive approach combining therapeutic modalities tailored to individual patient needs may offer the best outcomes for managing respiratory complications associated with cervical spondylosis.

Conclusion:

In conclusion, electromagnetic therapy demonstrated significant improvements in PaO2 and PaCO2 levels compared to other treatment modalities, suggesting its potential for enhancing respiratory function in patients with cervical spondylosis. On the other hand, breathing exercises showed improvements only in the FEV1/FVC ratio, with limited impact on other pulmonary parameters.

Recommendations for Managing Cervical Spondylosis:

1. Embrace Physical Therapy:

- It's crucial to embrace physical therapy methods such as electromagnetic therapyand breathing exercises within comprehensive treatment plans.

2. Conduct In-depth Studies:

- Undertaking larger-scale studies with expanded sample sizes is essential to delvedeeper into the effectiveness of various treatment approaches.

3. Tailor Treatment for Severe Cases:

- Tailor treatment strategies, including electromagnetic therapy and breathingexercises, to suit patients with advanced cervical spondylosis.

4. Ensure Long-Term Monitoring:

- Implement thorough long-term monitoring to track the enduring impacts of treatment modalities on respiratory health in cervical spondylosis patients.

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