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Analysis of Changes in Handgrip Strength and Blood Flow using Doppler Ultrasonography in Patients Receiving Chemotherapy

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KEYWORDS

Cancer, Chemotherapy, Hand Grip Strength

ABSTRACT:

Background: Cancer, the second leading cause of death globally, has witnessed a significant rise of cases in India over the past decade. Chemotherapy interventions, which often involve the intravenous administration of drugs, frequently result in vascular trauma. This trauma may lead to alterations in handgrip strength. However, there is sparse of evidences hence, this study aims to explore whether changes in blood flow caused by vascular trauma influence handgrip strength in chemotherapy patients.

Methodology: This observational study conducted with 22 consented patients, aged between 22 to 72 years of both genders receiving intravenous chemotherapy. The changes in the handgrip strength measured using electronic Camry hand grip dynamometer and blood flow parameters (vein diameter, thickness, velocity, and phasicity) using Doppler ultrasound were analyzed before and after chemotherapy sessions.

Result: The results reflecting a notable difference in handgrip strength between men and female ($p = 0.012$ in the pre-test, 0.026 in the post-test). In blood flow parameters vein diameter ($p=0.03$) and velocity ($p= 0.011$) had significant difference. The correlation between handgrip strength and blood flow velocity is 0.829 ($P=0.034$), showing a strong and statistically significant relationship. The Correlation between handgrip strength and wall thickness 0.282 ($p= 0.064$), suggesting a moderate and borderline statistically significance. The Correlation between handgrip strength and vein diameter is 0.118 ($p= 0.446$), indicating a weak and statistically insignificant relationship.

Conclusion: Overall, the study found reductions in blood flow parameters and handgrip strength in chemotherapy patients, particularly those receiving alkylating agents. The findings underscore the need for further research on the long-term effects of chemotherapy and methods to mitigate its severity.

1. Introduction

Cancer is the second leading cause of the adult death in Urban and fourth in rural India respectively, mortality has increased by nearly twofold from 1990 to 2016, with an estimated 1.15 million new cases in 2018, and is expected to roughly double by 2040 with demographic changes[1]. Chemotherapy is the most widely used cancer treatment and is intended to cure, control, or palliate cancer. There are studies revealed about local adverse effects of chemotherapy drugs due to intravenous (IV) administration causing vascular trauma due to inflammatory [2]changes and blood flow velocity variations and they also prone to develop pain and other severe complications [3] even fatigue which ends up affecting the handgrip of the patient[4]. These data are documented well as a side effect of neurotoxicity caused by dose-limiting anticancer agents[5]. However, there is still no data to imply that the handgrip strength can be impaired due to blood flow changes caused by IV

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cannulation and chemotherapy agents. Therefore, this study seeks to fill that gap by examining changes in the handgrip strength and blood flow in chemotherapy patients using Doppler ultrasonography.

2. Methodology

Ethical committee clearance was obtained from Sri Ramachandra Institute of Higher Education and Research Ethics committee for the student's proposal (CSP/19/SEP/80/354). This study also registered in CTRI Trial Registration (CTRI/2020/05/025121).

This study was designed as an observational study and conducted at Sri Ramachandra Hospital, Medical Oncology In-Patient ward who met the study criteria were included by obtaining informed consent. Patients who had stable vital signs, and patients receiving their first and second cycles of both palliative as well as adjuvant chemotherapy were chosen for the study. Those with a history of neuromuscular disorders, a history of any orthopedic conditions such as deformities, fractures, and implants, diabetes which has been present for quite a long period, and people who are not willing to take part were all excluded. The handgrip strength test was measured in the dominant hand using a validated electronic Camry hand grip dynamometer in reference with previous study[6]. They performed three maximum grip trials, resting for 30 seconds between each trial[7]. After IV cannulation the patients were taken to the ultrasound radiology department for Doppler screening. An assessment was conducted using an ultrasound system for the IV-cannulated veins before the chemotherapy drugs was placed. The radiologist examined the cannulated vein, evaluating parameters such as vein diameter, wall thickness, and blood flow velocity. Then those patients underwent chemotherapy depending on their condition and administering doses, before getting discharged[8]. The aim of the study was to evaluate the handgrip strength and Doppler screening of the participants on the subsequent day of IV placement and before IV placement for the next cycle of chemotherapy.

From the collected data, the incidence and prevalence of changes in blood flow parameters were evaluated and analyzed to correlate with the patients' handgrip strength during both the pre-chemotherapy and post-chemotherapy periods.

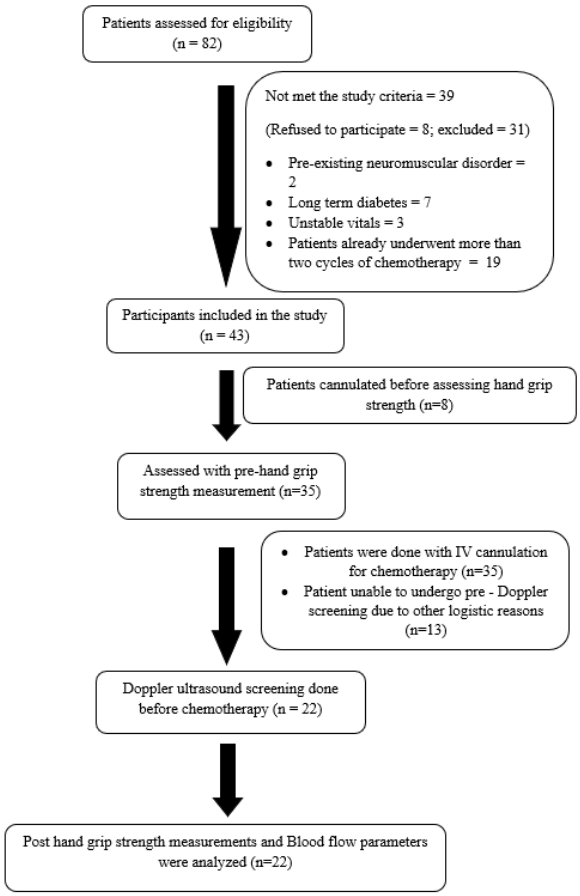

Figure 1. Methodology flow chart

3. Results

The statistical analysis of twenty-two chemotherapy patients was documented. The participant's age and Body mass index (BMI) data were reported as mean $\pm$ standard deviation; other demographic data are represented in percentages (Table 1). The reduction in vein diameter and blood flow velocity after chemotherapy was significant ($p<0.05$) (Table 2). Analysis showed that the reduction in the hand grip strength and wall thickness change were not significant ($p >0.05$). The analysis shows a significant positive correlation between handgrip and velocity of blood flow (p value= 0.034). The correlation of hand grip strength with vein diameter wall thickness was insignificant (Table 3).

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Table 1: Study Participants' Characteristics

Age*	48.13±13.69
Gender	
Male	9(41)
Women	13(59)
BMI (Overall)*	22.60 ± 3.08
Underweight	2(9)
Normal	18(82)
Overweight	2(9)
Personal habits	
Smoking	1(50)
Alcoholism	1(50)
Co- morbidities	
Hypertension	3(14)
Diabetes mellitus	3(14)
Diagnosis (regional)	
Thoracic	4(18)
Abdominal	12(55)
Musculoskeletal	6(27)
Chemotherapy characteristics	
1st cycle	11(50)
2nd cycle	9(40)
3rd cycle	1(5)
4th cycle	1(5)
IV line usage	
Metacarpal vein	12(55)
Cephalic vein	9(40)
Basilic vein	1(5)
Drugs prescription	
With alkylating agents	17(77)
Without alkylating agents	5(23)

BMI- Body Mass Index, IV- Intravenous, * presented in Mean± standard deviation

Table 2: Comparison of changes in measured primary variables before and after chemotherapy (n = 22)

Variables	Mean difference	Standard Deviation	p-value
Hand grip (kg)	0.101	1.824	0.799
Vein diameter (mm)	0.221	0.382	**0.013**
Wall thickness (mm)	0.068	0.228	0.175
Velocity (cm/s)	1.177	1.970	**0.011**

Kg – kilogram, **mm**- millimeter, **cm/s** – centimeter per second; Paired t test

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Table 3: Correlation of Hand grip strength and blood flow parameters

		Vein Diameter	Wall Thickness	Velocity
Handgrip	**Pearson Correlation**	0.118	0.282	0.829
(n = 44)	p value	0.446	0.064	**0.034**

Pearson correlation co-efficient

4. Discussion

This study aimed to analyse the handgrip strength in patients undergoing chemotherapy and the factors that contributing to these changes. The assessment of handgrip strength in patients undergoing chemotherapy has shown significant changes over a period of treatment course. The various factors contributing to these changes were vein diameter, wall thickness and velocity of blood flow.

The results reflected a notable difference in handgrip strength between male and female (p = 0.012 in the pre-test, 0.026 in the post-test), likely due to gender based variation reported in various literature[9], these changes can also be due to lower physical activity pattern exhibited by females compared to males [10], especially after menopause. In this study many of the women participants were homemakers possibly with less active lifestyles, could have contributed to their reduced handgrip strength [11]. Among the female participants in this study 75% of them fall under post –menopausal age. These aged women's' has higher susceptibility to have inflammatory changes[12], leading to changes in blood flow parameters based on vein diameter among women participants (p = 0.041). Peripheral vascular resistance is lower in obese individual compared to the normal individuals, the increase vascular resistance these has shown to cause changes in vein diameter (P= 0.030) in 86% participants with normal BMI. In total, 46% of patients experienced a decrease in vein diameter post chemotherapy

Changes in vein diameter are inversely related to blood flow velocity. The study revealed notable differences in blood flow velocity among women patients (p = 0.024) and those with a normal BMI (p = 0.018). Blood flow velocity gets markedly influenced by minor changes in vein diameter. Additionally, significant differences were noted in patients receiving infusions through MCP veins (p = 0.031), which are smaller and more susceptible to occlusion from chemotherapy drugs. Patients treated with alkylating agents [13] exhibited significant changes in blood flow velocity (p = 0.031). In total, 46% of patients experienced notable changes in blood flow velocity, and 10% faced complete vein occlusion, especially in overweight female at advanced cancer stages who were treated with alkylating agents via the cephalic vein. These changes were attributed to complications from chemotherapy.

There was also significant difference in wall thickness (p = 0.015) seen in patients underwent chemotherapy with alkylating agents, similar results were showed in previous studies. It was found that 22% of the participants have developed wall thickness.[14, 15]

Phasicity is the role of respiration plays in venous flow patterns. Phasicity will be present or absent based on the presence of blood flow in a vein. In this study, 10% of patients developed phlebitis and 10% of patients had an absence of phasicity with no measurable blood flow velocity in the vein used for IV chemotherapy.

The study revealed a notable positive relationship between handgrip strength and blood flow velocity (p = 0.034), which aligns with findings from other research [15,16]. Variations in these factors were not significant across different stages of cancer, likely due to inflammatory changes caused by chemotherapy. Furthermore, 10% of patients experienced phlebitis, resulting in vein occlusion and a lack of blood flow velocity after chemotherapy. Performing handgrip exercises may enhance hand functions, to maintain muscle mass and strength of forearm and also prevent complication [17]. Therefore future experimental studies are required to confirm the benefits of hand grip exercise in cancer patients undergoing chemotherapy and improving the blood flow parameters. In summary, while chemotherapy led to decreased blood flow parameters and handgrip strength, handgrip exercises were beneficial.

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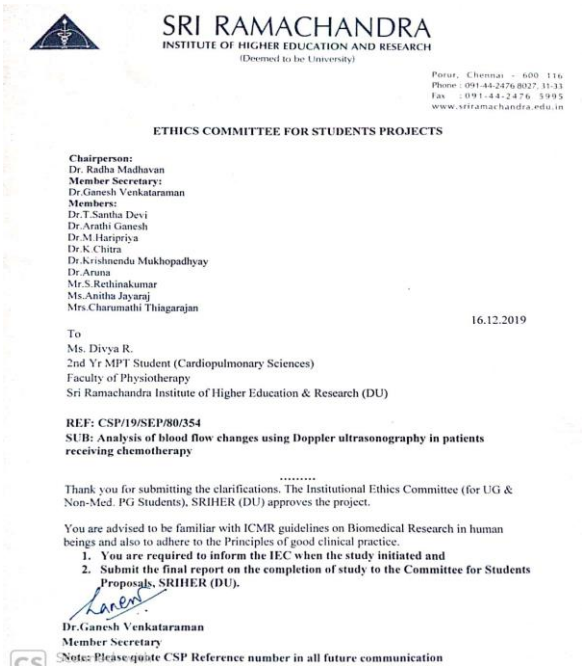
5. Conclusion

Most of the patients receiving chemotherapy had reduction in blood flow parameters and handgrip strength. Among them, patients receiving chemotherapy with alkylating agents have higher risk of developing vascular impairments and handgrip strength reduction. There was a significant positive correlation between handgrip strength and blood flow velocity. The benefit of exercises needs to be verified with future research in a larger sample and with longer follow-up duration for consequent chemotherapy cycles.

6. Acknowledgment

It is our privilege to thank the management of Sri Ramachandra Institute of Higher Education and Research (Deemed to be University). With due respect we thank the HOD, Department of Medical Oncology, we would also like to thank the HOD, Department of Radiology for their guidance and kind help towards me throughout this study.

Ethical Approval Letter



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16.12.2019

To
Ms. Divya R.
2nd Yr MPT Student (Cardiopulmonary Sciences)
Faculty of Physiotherapy
Sri Ramachandra Institute of Higher Education & Research (DU)

REF: CSP/19/SEP/80/354
SUB: Analysis of blood flow changes using Doppler ultrasonography in patients receiving chemotherapy

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Thank you for submitting the clarifications. The Institutional Ethics Committee (for UG & Non-Med. PG Students), SRIHER (DU) approves the project.

You are advised to be familiar with ICMR guidelines on Biomedical Research in human beings and also to adhere to the Principles of good clinical practice.

1. You are required to inform the IEC when the study initiated and
2. Submit the final report on the completion of study to the Committee for Students Proposals, SRIHER (DU).

Dr.Ganesh Venkataraman
Member Secretary

Note: Please quote CSP Reference number in all future communication

Abbreviations

S. No	Short Forms	Abbreviations
1	IV	Intravenous
2	BMI	Body mass index

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