Effect of Cooling Cap on Controlling Alopecia for Women Undergoing Chemotherapy

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Abstract

Background: Alopecia is an unpleasant side effect of chemotherapy that, on occasion, might cause patients to refuse treatment. The use of a cooling cap can help prevent chemotherapy-related alopecia. **The aim of the study:** is to determine the effect of cooling cap on controlling alopecia for women undergoing chemotherapy. **Materials and methods:** The study design used was a quasi-experimental research design. A purposive sample of 60 adult female patients, at the Oncology Center and Oncology clinic in Minia University age, ranged from 21 to 60 years old, with cancer and scheduled to be treated with adjuvant chemotherapy for the first time after curative surgery who met the inclusion criteria will be divided randomly 30 subjects in study group and 30 subjects in the control group, the study group were received cooling cap while they receiving their chemotherapy cycle while the control group received the routine hospital care. 2 tools used to include structure interview questionnaire and physiologic measurement tool for hair loss. **The results of this study:** There were 43.3% &3.3% have grade 4 (total alopecia) from the control and study group (CCG) respectively after the six cycles of chemotherapy. There is a highly significant difference between the two groups regarding grades of hair loss and there is good hair preservation by 86.7% in the study group (cooling cap group (CCG)) compared to 16.7% in the control group where P=0.000. **Conclusion:** The cooling cap is effective in the prevention of chemotherapy-induced alopecia in cancer patients. **Recommendation:** The cooling cap is effective and should be applied for cancer patients during chemotherapy cycles thus the cooling cap system should be available in governmental hospitals and the women with cancer who take adjuvant chemotherapy should be encouraged to use cooling cap to reduce total alopecia. Further psychological, clinical, and biological research is needed to improve the effect, tolerance, time, and side effects of the cooling procedure.

Keyword: Cooling Cap, Controlling Alopecia, Undergoing Chemotherapy

Introduction

Cancer is a group of diseases characterized by uncontrolled growth and spread of abnormal cells. If the spread is not controlled, it can result in death. Cancer is caused by both external factors (tobacco, infectious organisms, chemicals, and radiation) and internal factors (inherited mutations, hormones, immune conditions, and mutations that occur from metabolism). These causal factors may act together or in sequence to initiate or promote the development of cancer. Ten or more years often pass between exposure to external factors and detectable cancer. Cancer is treated with surgery, radiation, chemotherapy hormone therapy, biological therapy, and targeted therapy **(Lugtenberg, et al., 2022).**

7.6 million Deaths (or almost 13% of all deaths) were caused by cancer in 2022, making it the first leading cause of death globally. The main types of cancer are Lung 1.3 million deaths/year, and Stomach (803.000 deaths). Colorectal (639.000 deaths). Liver (610.000 deaths). Breast (519.000 deaths). More than 70% of all cancer deaths occurred in low- and middle-income countries. Deaths from cancer worldwide are projected to continue rising, with an estimated 11.5 million deaths in 2030. It affects all races and age groups, although it is more prevalent in the elderly and certain geographical regions **(Burke Lemone and**

Mohn-brown, 2017).

Chemotherapy; the treatment of cancer with chemical agents, is used to cure and to increase survival time. It has some selectivity for killing cancer cells over normal cells. This killing effect on cancer cells is related to the ability of chemotherapy to damage DNA and interfere with cell division. Tumors with rapid growth are most sensitive to chemotherapy **(Freites, et al.,2019)**

Damage to normal cells results in chemotherapy toxicities and side effects, it can be seen that those actively dividing tissues such as bone marrow, hair follicles, and gastro-intestinal mucosa are most vulnerable. Side effects of chemotherapy range from mild, like nonspecific tiredness to life-threatening as in neutropenic fever **(Bajpai, et al., 2020).**

Chemotherapeutic agents have the ability to kill dividing cells, without affecting normal cells that are in a resting stage. Since most cells in the human body are in a resting stage at any given moment, and cancer cells are often in a dividing stage, cancer cells are more susceptible to damage than healthy cells. However, certain healthy cell types in the human body also multiply quickly, such as the blood cells forming in the bone marrow and hair follicles. These healthy cells are also affected by chemotherapy and this leads to side effects such as fatigue, nausea, and hair loss (alopecia) **(Rugo, et al., 2017).**

Chemotherapy-induced alopecia (CIA) is a frequent toxicity and arguably the most feared side effect of cancer chemotherapy. The incidence of chemotherapy–induced alopecia is approximately 65% of all patients. Chemotherapy-induced alopecia could be easily noticeable by self and others in a relatively short time, thus it is linked with cancer and chemotherapy. Chemotherapy-induced alopecia (CIA) compromises patient quality of life, especially for females and children, leading to poor therapeutic outcomes. Despite significant progress and substantial efforts in chemotherapy-induced alopecia research and development, no reliable and effective preventive treatment has become available. Chemotherapy causes structural damage to human scalp hairs. The effects may vary from altered hair appearance, decreased rate of hair growth, partial or complete hair loss (alopecia) **(Shah, et al., 2018).**

Scalp cooling caps can be one solution for chemo-related hair loss. Scalp cooling, also called scalp hypothermia, involves the cooling of the scalp with cold caps before, during, or after a treatment of chemotherapy. New versions of scalp cooling caps are developed as a two-piece system. A computer controls the circulation of cooled liquid throughout the cap worn during treatment. A second neoprene cap covers the cooling cap to maintain the lower temperature. Two cooling cap systems that have received (FDA) Food and Drug Administration approval are produced by Paxman , Amma and DigniCap. Cooling caps can be used to reduce hair loss in those with solid tumors **(Chan, et al., 2018).**

Hair loss may be more threatening for women, perhaps because women's hair is regarded as an indicator of personality, attractiveness, and femininity. Forty-seven percent of female cancer patients consider hair loss to be the most traumatic aspect of chemotherapy and 8% would even decline treatment for fear of this impeding side- effect. Therefore, the effect of chemotherapy-induced hair loss on patients is minor concern to nurses and physicians. However, for patients, chemotherapy-induced hair loss is one of the most feared side effects of cancer therapy. Although not highly detrimental to physical health, hair loss can be psychologically devastating and can even lead some patients to reject potentially curative treatment **(Marks, et al., 2019).**

Significance of the Study

Cancer is a major public health problem in the United States and many other parts of the world. One in 4 deaths in United States is due to cancer. A total of 1,660,290 new cancer cases and 580,350 cancer deaths are projected to occur in the United States in 2022. Incidence of cancer in Europe and the United States amounting to 5 times happens in Egypt, there are 100 to 200 new cases each year for every one hundred thousand Egyptian citizens, while the United States and European countries to have 400 500 new cases per hundred thousand

citizens **(Munzone, et al., 2019)** The statistical record of the oncology center at Minia University illustrated that 12.576 patients were diagnosed with cancer in the year 2022.

Cooling cap is the most effective method to prevent chemotherapy-induced alopecia (CIA). The CIA may be prevented by cooling caps before, during, and sometimes after chemotherapy infusion. Cooling cap has been practiced since the 1970s. In currently used chemotherapies scalp cooling equipment prevents severe hair loss in about half of the patients. The mechanism of cooling cap to prevent alopecia is based on the theory that cooling of scalp skin during chemotherapy infusion reduces blood flow and thus there is less uptake of drug in the hair follicles. Cooling of the scalp skin can also reduce local tissue metabolism. It seems there are many factors that influence the effectiveness of cooling cap to prevent alopecia as the differences in the doses and combinations of chemotherapeutic agents, the cooling time, cooling temperature, the condition of the hair, and the cooling device may also be variable. Therefore, this study aims to determine the effect of cooling cap on controlling alopecia in women undergoing chemotherapy **(Novice, et al., 2020).**

Aim of study

This study aimed to determine the effect of cooling cap on controlling alopecia for women undergoing chemotherapy.

Research hypothesis

Study group patients who were exposed to cooling cap intervention had less hair loss than the control group patients who were not exposed to such intervention.

Materials and Methods

Design:

A quasi-experimental research design was utilized in this study.

Setting of the study:

This study was conducted at the Oncology Center and Oncology Clinic in Minia University Hospital. With an area of 1,500 m^2 per floor, and a total built-up area of 7,500 m^2, the building comprises a basement, ground floor, and four typical floors. The center contains internal department and outpatients clinics. Clinic located in the second floor and contains two rooms each one had 20 beds.

Subjects:

A purposive sample of 60 adult female cancer patients, ages 21-60 years old, scheduled to be treated with adjuvant chemotherapy for the first time after curative surgery and met the inclusion criteria recruited for this study based on EPI info program version 6.02 after taking into consideration the clinical incidence of 33.3 from the hospital record with the study power 80%, confidence interval of 95% and relative precision 15%. The subjects (60 patients) were divided randomly into 30 patients in the study group (Cooling cap group (CCG)) and 30 patients in the control group, the study group received cooling caps among received chemotherapy administration while the control group received the routine hospital care.

Tools:

The data of this study were collected by using two tools such as the following:

Tool 1: Structure interview questionnaire and hair assessment tool:

This tool was developed and tested by the researchers after an extensive review of related literature **(Rossi, et al., 2020**; **American Cancer Society (ACS), 2020).** It was written in simple Arabic language this tool consists of five parts:

Part 1: included demographic data such as age, marital status, employment status, residence, and level of education.

Part 2: Covered clinical data and medical history as date of admission, stage of disease, any prescribed medication, type of operation, and past medical history.

Part 3: Was used to identify data about hair loss and cooling cap conditions such as causes of hair loss, grades of hair loss, and presence of other scalp problems.

Part 4: Covered data about cooling cap as how, when and how will perform cooling cap.

Part 5: Included data to evaluate the side effects of cooling caps such as feeling cold, needing a blanket for warmth, having headaches, and feeling bored.

Tools II: Physiological measurement tool.

It was developed by WHO and it was used in this study to assess the physiologic measurement of hair loss during each cycle of chemotherapy. The scale is a 5-point scale ranging from 0 (Not significant hair loss) to 4 (Total alopecia). The patient's head is observed measured pre-and after each cycle and compared with the previous cycle. The difference between pre and after each cycle is ranked according to WHO criteria and the difference between the current cycle and the previous cycle measurement is ranked according toWHO criteria.

WHO criteria for hair loss according to (Kinoshita, et al., 2019)

Grade 0: Not significant hair loss.
Grade 1: Minor hair loss, not requiring awig.
Grade 2: Moderate hair loss, but not requiring a wig.
Grade 3: Sever hair loss requiring a wig.
Grade 4: Total alopecia**.**

Tools validity and reliability:

The current validity was established by a panel of eight experts (five professors nurses and three physicians working in an oncology center), who reviewed the tools for clarity, relevance, comprehensiveness, understanding, and simplicity for implementation, and according to their opinion, some modification was applied.

The reliability of both tools was tested using split-half methods and Cronbach's alpha which measures the degree of reliability for the entire form. Both techniques showed high reliability of the final version of the tool. (Alpha=0.85)

II. Administrative design and Ethical considerations

Written permission to conduct the study was obtained from the director of the oncology center and oncology clinic at Minia University Hospital, as well as the head nurses. This was achieved after a clear explanation of the nature and purpose of the study as well as its expected outcomes.

Ethical approval to conduct the study was obtained from the Ethics Committee of the Faculty of Nursing, at Minia University (REC202053). Written consent was obtained from patients and informed that their participation in the study is optional and that they may withdraw at any time during the study when they decide.

III. Operational design

The operational design includes a preparatory phase, pilot study and fieldwork.

A. Preparatory phase:

It includes reviewing the current and past available literature on the various aspects of the problem using, articles, periodicals, magazines, and textbooks was conducted over a period of 20 months. This literature related to the study's aim, in order to develop the data collection tools.

B. Pilot Study

Testing of the selected tools was carried out before starting the data collection; it was applied to a group of 10% total number of female patients with cancer and undergoing adjuvant chemotherapy. It was done to test the applicability, feasibility, simplicity, and clarity of the questions. The patients in the pilot study were excluded from the study group. Some modifications were done accordingly.

C. Field Work

The actual field work started in May 2023 and end at November 2023 It started by interviewing the patients, who participated in the study and met the inclusion criteria individually by the researcher at the above-mentioned settings. The researcher started by introducing herself to the study subject. Clarification of the nature and purpose of the study was done, in case of positive verbal answers and agreement to participate before implementing cooling cap.

1. The first interview was done before starting their chemotherapy cycle to collect baseline data that included demographic data, current and past medical history, and hair

assessment by using tool 1 (Structure interview questionnaire sheet and hair assessment tool). The second interview was done at the end of the chemotherapy cycle to collect data about their loss by using tool II (physiologic measurement tool for hair loss by using the WHO grading system). The interview took almost 30 minutes each interview. Then the patient was interviewed according to their chemotherapy cycle.

2. Patients undergoing, cervectomy and hysterectomy received FAC (Floururacil Adriamycin Cyclophosphamide (Endoxan). These cycles are repeated every 21 days for 6 cycles.

3. Patients undergoing ovariectomy were received (Taxol- carpolinate). These cycles are repeated every 21 days for 6 cycles.

4. Patients undergoing colectomy take treatment chemotherapy (Foulox).

- Each cycle (is taken every week and rest for 2 weeks then repeated 3 times) the patient takes 3 cycles.
- During the administration of the chemotherapy the patient in the study group they treated with cooling cap machine (Orbis Paxman cooling cap machine).
- It was applied to the scalp half an hour before starting chemotherapy, during chemotherapy, and one hour after accomplishing chemotherapy. Temperature kept at $3C^{o}$.
- The control group was treated with routine hospital care that did not include cooling cap
- The researcher assessed the patient's hair before and after each chemotherapy cycle by using the WHO grading system of hair loss.
- The assessment has been done for the study and control group at the same time before and after each chemotherapy cycle through the study period.

Handling and analysis of data:

- The raw data were coded and entered into SPSS system files (SPSS package version 18). Analysis and interpretation of data were conducted. The following statistical measures were used:
- Descriptive statistics including frequency, distribution, mean, and standard deviation were used to describe different characteristics.
- The Kolmogorov-Smirnov test was used to examine the normality of data distribution.
- Univariate analyses using the Chi-Square test were used to test the significance of the results of qualitative variables.
- Liner correlation was conducted to show the correlation between knowledge, attitude, and practice scores among the studied healthcare workers.
- The significance of the results was at the 5% level of significance.

Results

Table (1): This table shows demographic data for the women with cancer and undergoing adjuvant chemotherapy that exactly half (50%) and less than half (43.3%) 0f control and study group their age ranged from 40-49 years old in both groups respectively. Two -thirds of the women in both groups (control group and study group) were married (73.3%) and (76.7%), respectively. As regards residence exactly half of the control group lives in rural areas and 50% live in urban areas but in the study group above half of the sample live in rural areas (56.7%) and only 43.3% live in urban areas. About educational level, more than half of the women in the control group (53.3%) and more than two-thirds of the study group sample (70%) have secondary education. The majority of both groups (control group and study group) 90% and 86.7% respectively, live with family. In relation to occupation there were 70% of women in control group and 60% in study group were housewives. There is no significant difference between the control group & study group regarding demographic data (P>0.05). In relation to their treatment most of them were treated with FAC (Floruracil-Adriamycin cyclophos- phamide (Endoxan) (56.7% and 50%) for the control group and study (scalp cooling group (CCG)) group respectively. In relation to the operation type there were; (3.3% &0.0%) of those who underwent cervectomy, for the control group and study group respectively, and nearly half (46.7%) who underwent mastectomy, for the control group and study group (P>0.05).

Table (2): Represents a comparison between control and study (CCG) groups regarding alopecia that all women (100%) in the control group and the majority of the women (96.7%) in the study group (SCG) had hair loss and all women (100%) in both groups suffering hair loss more than a month. There is no significant difference between the study group (CCG) & the control group regarding alopecia questions (P>0.05). As regards the degree of hair loss according to the WHO scaling system for hair loss, there is a highly significance difference

between the two groups regarding the degree of hair loss(P=0.000) as in the control group there were (46.7%) suffering total alopecia in comparison to studying group (CCG) there were (3.3%) suffering total alopecia.

Table (3): This states the prevalence of cooling cap side effect, where 100% of the study group (cooling cap group) suffered from feeling cold and 70% needed a blanket for warmth during this procedure. And 100% had suffered from headaches and felt bored.

Table (4): This reports a comparison between the control group and study group (CCG) in grades of hair loss before the first cycle and after the six cycles of chemotherapy there were 63.3% &0% were in grade 1 from the study group (CCG) and control group respectively. While (43.3% &3.3%) have grade 4 (total alopecia) from the control and study group (CCG) respectively after the six cycles of chemotherapy. There is a highly significant difference between the two groups regarding grades of hair loss (P<0.000).

Table (5): observes the relation between the type of chemotherapy and grades of hair loss after the sixth cycle of chemotherapy in both control and study groups (CCG) that there were 40% of the women treated with taxol-carpolinate in the study group had grade 1 hair loss and 40% have grade II of hair loss while 60% from the women who treated with Taxol-carpolinate in the control group have grade III hair loss. About the women treated with FAC (Fluorouracil-Adriamycin-Cyclophosphamide (Endoxan)) there were 60% of the women in the study group (CCG) had grade I hair loss while in the control group there were 70.6% had grade IV hair loss. As regards the women who were treated with Flox there were 80% of the study group had grade I hair loss while 62.5% of the control group had grade III. There were significant differences between the two groups in grades of hair loss about the type of chemotherapy.

Table (6): Clears the relation between age & grades of hair loss after the 6th cycle among study group (CCG) that all women whose age ranged from (21-39) years old have grade 1 hair loss and 46.2% from the women whose age ranged from (40-49) have grade 1 hair loss. Otherwise, 40% of women aged from (50-60) have grade II hair loss. This means that there was a significant difference between younger age women (most of them have grade 1) & older age women (have grade II, III, and IV) and the grades of hair loss. (P<0.05).

Table (1): Demographic data of the study and control groups.

Demographic data	Control group(N=30)		Study group(N=30)		X^2	p-value
	No	%	No	%		
Age grouping:						
21<39	6	20.0	12	40.0		
40<49	15	50.0	13	43.3	3.286	0.193
50<60	9	30.0	5	16.7		
Marital status:						
Single	2	6.7	1	3.3		
Married	22	73.3	23	76.7	0.698	0.874
Widow	4	13.3	3	10.0		
Divorced	2	6.7	3	10.0		
Residence						
Rural	15	50.0	17	56.7	0.268	0.605
Urban	15	50.0	13	43.3		
Educational level						
Read and write	10	33.3	2	6.7		
Secondary education	16	53.3	21	70.0	6.827	0.033
Academic education	4	13.3	7	23.3		
Living status						
Live with family	27	90.0	26	86.7	0.162	0.688
Live alone	3	10.0	4	13.3		
Occupation:						
Student	1	3.3	0	0		
Employee	7	23.3	11	36.7	2.120	0.548
House wife	21	70.0	18	60.0		
Retired	1	3.3	1	3.3		
Types of cancer's drugs						
Toxol-carpolinate	5	16.7	5	16.7		
FAC (Floruracil-Adriamycin-Cyclophosphamide (Endoxan)	17	56.7	15	50.0	0.347	0.841
Foulox	8	26.7	10	33.3		
Operation type						
Ovariectomy Cervectomy	5	16.7	5	16.7		
Coleictomy Hysterectomy	1	3.3	0	0	1.556	0.817
Mastectomy	8	26.7	10	33.3		
	2	6.7	1	3.3		
	14	46.7	14	46.7		

Table (2): Comparison between the control group and study group regarding alopecia questions.

Alopecia questions	Control group (N=30)		Study group (N=30)		X^2	p-value
	No	%	No	%		
Suffering from hair loss						
Yes	30	100.0	29	96.7	1.017	0.313
No	0	0.0	1	3.3		
Time of hair loss						
More than a month	30	100.0	30	100.0	-	-
Degree of hair loss						
0- Not significant hair loss	0	0.0	1	3.3		
1- Minor hair loss not requiring a wig	0	0.0	19	63.3		
2- Moderate hair loss not requiring a wig	4	16.7	6	20.0	37.067	0.000**
3- Sever hair loss, requiring a wig	12	40.0	3	10.0		
4-Total alopecia	14	43.3	1	3.3		
Other scalp problems before chemo-therapy						
No	30	100.0	30	100.0	-	-

Table (3): Prevalence of side effects of cooling cap among study group (SCG)

Cooling cap side effects	Study group (No=30)	
	No	%
Feeling cold: -		
Yes	30	100.0
No	0	0.0
Blanket for warmth: -		
Yes	21	70.0
No	9	30.0
Headache: -		
Yes	30	100.0
No	0	0.0
Feeling boring: -		
Yes	30	100.0
No	0	0.0

Table (4): Comparison between the control group & study group (CCG) in grades of hair loss according to WHO before the first cycle and after the sixth cycle of chemotherapy.

Grades of hair loss	Control group				Study group				X2		p-value	
	Before cycle 1		After cycle 6		Before cycle 1		After cycle 6		Before cycle 1	After cycle 6	Before cycle 1	After cycle 6
	No	%	No	%	No	%	No	%				
0			0	0.0			1	3.3				
1	30	100.0	0	0.0	30	100.0	19	63.3				
2	0	0.0	5	16.7	0	0.0	6	20.0	1.017	35.777	0.313	0.000**
3			12	40.0			3	10.0				
4			13	43.3			1	3.3				

Table (5): Relation between grades of hair loss and type of chemotherapy after the six cycles of chemotherapy among the study group (CCG) and control group.

Grades of hair loss	Type of chemotherapy in CCG group (No=30)						Type of chemotherapy in control group (No=30)						X2		P-value	
	Taxol-carpolinate		FAC (Floururacil Adriamycin - Cyclophos-phamide (Enodoxan)		Foulox		Taxol-carpolinate		FAC (Floururacil Adriamycin-Cyclophospha-mide (Enodoxan)		Foulox					
	No	%	No	%	No	%	No	%	No	%	No	%	SCG	control	SCG	control
Grade 0	0	0.0	0	0.0	1	10.0	-	-	-	-	-	-				
Grade 1	2	40.0	9	60.0	8	80.0	-	-	-	-	-	-				
Grade 2	2	40.0	3	20.0	1	10.0	1	20.0	1	5.9	3	37.3				
Grade 3	1	20.0	2	13.3	0	0.0	3	60.0	4	23.5	5	62.5	7.061	15.962	0.530	0.003*
Grade 4	0	0.0	1	6.7	0	0.0	1	20.0	12	70.0	0	0.0				

Table (6): Relation between age & grades of hair loss after 6th cycle among study group (CCG) (N=30)

Grade of hair loss	Age						X2	P-value
	21<39		40<49		50<60			
	No	%	No	%	No	%		
Grade0	0	0.0	1	7.7	0	0.0		
Grade1	12	100.0	6	46.2	1	20.0		
Grade2	0	0.0	4	30.8	2	40.0		
Grade3	0	0.0	2	15.4	1	20.0	17.174	0.028*
Grade4	0	0.0	0	0.0	1	20.0		

Discussion

Chemotherapy-induced hair loss occurs with an estimated incidence of 65%. Forty–seven percent of female patients consider hair loss to be the most distressing side effect of chemotherapy and 8% would decline chemotherapy due to fears of hair loss. Chemotherapy-induced temporary hair loss is one of the most common and emotionally distressing side effects of cancer therapy. Since about 1970, many preventive measures have been tried to reduce chemotherapy-induced alopecia tourniquets, medicaments, and scalp cooling. Currently, preventive measures mainly focus on cooling caps **(Rice, et al., 2018).**

Discussion of the study results will cover five main areas; the first part is concerned with the representation of demographic characteristics of the study group as patient's assessment regarding present medical history and health state. The second represents the effectiveness of the cooling cap in the prevention of hair loss according to the WHO scaling system for hair loss. The third part is concerned with the side effects of the cooling cap. The fourth part is concerned with the effectiveness of cooling caps with different types of chemotherapy. Finally, the fifth part is concerned with the relation between demographic data and grades of hair loss.

Part I: demographic characteristics

The results of the current study revealed that less than half of the participants were female in the study group and exactly half of the participants were female in the control group their ages ranged from 40-49 years old. Interestingly, in the same line **(Rugo, et al.,2017),** who found that most of the participant patients in the study and control groups their age ranged from 40-49 years old. This may be due to females being exposed to more stress, nutritional deficiency, obesity, and hormonal changes at that age.

Regarding marital status the majority of the women in the study group and control group were married, this is consistent with **(Sonpavde, et al., 2018),** who found that the majority of the study and control group were married. This may be due to the women included in the study from 18-60 years old "productive life" so it is normal for the majority of them to be married. This may indicate that marriage-associated problems may result in cancer either to increasing workload, responsibilities, and stress. In relation to educational level, more than two-thirds of the study group and slightly more than one-half of the control group had secondary education. This result is consistent with **(Olsen and Naseman, 2019)** who had most of the patients with secondary education but contradicts with **(Belum, et al., 2016)** who had the most of their participant patients with University education. This difference may be due to the difference between countries regarding awareness and culture. This level of education may affect the level of awareness and understanding regarding the preventive information of cancer and also the importance of its early detection through scheduled follow-up

The current study revealed that slightly more than one-half of the study group and one-half of the control group reside in rural areas and the majority of the women in both groups live with their family. This agrees with **(Komen, et al., 2019),** who found that most patients reside in rural areas and live with their families.

The women in the current study have different types of cancer and have undergone the prescribed type of operation accordingly as slightly less than half of the study group undergone mastectomy and the rest undergone

different types of operations such as; ovariectomy, colectomy, hysterectomy, and cervectomy from both groups. This result agrees with a study done by **(Vasconcelos, et al., 2018)** who have their study patients undergone several types of operations such as mastectomy, ovariectomy, and colectomy. The result is also supported by the study done by **(Martin, et al., 2018),** who has studied patients undergone many types of cancer surgery as breast cancer, ovariectomy, and gastrointestinal operations but the majority of them have had operation due to breast cancer.

The result contradicts the study result done by **(Rubio, et al., 2018),** whose study group underwent mastectomy only. This means that the researchers who stabilized the type of operation for the study group wanted to stabilize the type of chemotherapy and examine the effect of scalp cooling on that medication while those who used several types of cancer operations wanted to examine the effect of scalp cooling on different types of chemotherapy used after these operations. Also, the majority of patients had mastectomies because the studied samples were female, this finding was matched with the **National Cancer Institute (2011),** which reports that the majority of breast cancer cases are females.

Most of the women in both groups were in the 2nd stage of their disease, and most of them complained about the disease for 1-3 years. This result agrees with the study done by **(Anderson and Matey, 2019)** who found patients in the study group were in the early stage of the disease and the length of the disease occurred within 1-3 years in most of the patients.

Both groups in the present study were treated with an intravenous (IV) chemotherapy drug regimen. The treatment schedule included six cycles of chemotherapy at intervals of 3 weeks. Including one of the following major alopecia-causing agents and these drugs were given according to the type of operation, women undergoing ovariectomy take Taxol-caroline (paclitaxil), women undergoing mastectomy, hysterectomy and cervectomy take FAC (5-Floruracil- Adriamycin in (Doxorubicin) - Cyclophosphamide (Endoxan) and for women undergone colectomy take Flox (F=Fluorouracil, L= Leucovorin, OX= Oxaliplatin) thus most of them in both control group and study group were treated with FAC (5- Fluorouracil - Adriamycin (Doxorubicin) - Cyclophosphamide (Endoxan).

This result agreed with a study done by **Hurk van den et al. (2013),** who found cancer patients participants receiving FAC, Paclitaxel, and docetaxel, the treatment schedule included six cycles of chemotherapy at intervals of 3 weeks.

This is also, in the same line with whose patients were treated with FEC (5 - Floruracil-Epirubin-Cyclophosphamide (Endoxan). Also, agree with the results of **(Anderson and Matey, 2019)** that had the patients treated with doxorubicin, docetaxel, and FAC. Also, in agreement with the study result **(Rubio, et al., 2018)** who used the FAC regimen in the treatment of breast cancer patients. The treatment schedule included six cycles of chemotherapy at intervals of 3 weeks.

This disagrees with **(Copur et al., 2018)** who used Docetaxel in the treatment of breast cancer. Also disagree with **(Holmes, et al., 2018)** who had cancer patients participants receiving Adriamycin and vincristine, Taxotere (Docetaxel) Taxol, and Adriamycin. These differences may be due to variations in the treatment regimen according to the hospital protocol in sequence with the operation type.

The study group in the present study was treated by scalp cooling during the administration of the chemotherapy by using a scalp cooling machine (Orbis Paxman cooling cap machine). It was applied to the scalp half an hour before starting chemotherapy, during chemotherapy, and an hour after accomplishing chemotherapy. Temperature kept at -3C^{o}. This agrees with the study done by (Holmes, et al., 2018) who use the same cooling machine (Orbis Paxman) and is applied to the scalp starting approximately 30 minutes prior to chemotherapy and must continue for 30 to 90 minutes after the conclusion of treatment but they disagreed in the temperature on the surface of the scalp below which at-18C^{o}. This difference in the utilized temperature may be due to the difference between countries in relation to the atmosphere.

The result disagrees with the result of the study done by **(Copur, et al., 2018& Reiss et al., 2018)** who used penguin caps as scalp cooling devices which these caps needed to be changed

frequently during the administration of chemotherapy but agreed with them in the cooling period and the cooling temperature as applying the cooling caps half hour before starting chemotherapy, during chemotherapy and up to 90 minutes after accomplishing chemotherapy and the temperature of the cap had to be below-25C^{o}.

The result also contradicts with study result **(Thomas, et al., 2018)** who used manually cooled caps at 8co and the caps remained on the scalp for 15 minutes only after infusion of chemotherapy. This difference may be due to the availability of the cooling system in the hospital or the facility to obtain the devices of cooling cap to apply it.

The scalp must remain cold during the time that the drugs causing alopecia are at their highest plasma concentration. Complex pharmacokinetic data are often involved when considering drug half-lives. In theory, the scalp should remain cold until the level of active drug or its metabolites is reduced to sufficiently low levels in the plasma. However, data regarding the levels at which a drug no longer causes alopecia are often not available and therefore, recommendations for scalp-cooling times are often based on experience.

Part II: Effectiveness of cooling cap in controlling hair loss according to WHO scaling system for hair loss:

According to the aim of this study, to determine the efficacy of a cooling cap on the controlling of alopecia in cancer patients undergoing adjuvant chemotherapy, the results of the current study revealed that after the last chemotherapy session, there was a statistically highly significant improvement among study group (CCG) in comparison to control group regarding alopecia where p- value=0.000 that there was success rate in the majority of patients in the study group who didn't need to wear a wig (grade0, 1, 2) while in the control group there were above quarter who had the same grades. In the control group, the majority of patients were required to wear a wig (grade 3, 4) in comparison to less quarter of the patients in the study group who needed to wear a wig (grade 3, 4).

This result agreed with a study done by **(Kruse and Abraham, 2018)** who found that the most of patients in the study group (CCG) were not required to wear a wig (grade 0, 1, 2,) & all of the patients in the control group required to wear a wig (grade3, 4). The result also agrees with the result of the study done by **(Kang et al.,2019)** who reported that there was a success rate (grade 0, 1, 2) in mostly of cold caped patients (study group) who weren't required to wear a wig and found that there was success rate (grade 0,1,2) in the majority of scalp cooled patients.

The study result is also consistent with the study of **(Hurk van den., et al., 2013)** who achieved a success rate in half of the patients who weren't required to wear a wig (grades 0, 1, 2).

Moreover, the finding disagrees with the result reported by **(Smetanay, et al., 2019)** who reported that the success rate was only (10%) from the cooled cap patient which was nearly similar to the control group. This difference may be due to that the last author used manual caps kept at 8co and remained on the scalp for 15 minutes only after infusion of chemotherapy and the cooling cap as reported by most references should be applied 30 minutes before starting chemotherapy and during infusion period and after accomplishing chemotherapy from 30-90 minutes and the cooling temperature should be kept below-25c° as the current study and the supported authors utilize types of cooling cap that deliver cooling to the scalp according to these references.

There was a statistically highly significant difference between the study group (CCG) & control group regarding the grades of hair loss p-value=0.000 as slightly more than half of patients who were treated with cooling cap (study group) had grade 1 hair loss while only a minority from them had grade 4 hair loss. On the other hand, slightly less than half of the patients in the control group who received routine hospital care had grade 3, and also, slightly less than half of them had grade 4 hair loss.

In the same line **(Hurk van den, et al., 2013)** reported that half of the patients who were treated with a cooling cap and grade 2 hair loss while in the control group, the majority had (grades 3&4). Also, the result is supported by **(Nangia, et al., 2017)** who reported that nearly two third of patients in the cooled cap group (study group) had (grades 1& 2) while in the control group, all of the patients had (grades 3, 4).

The result is also in agreement with the result of the study **(Bajpai, et al., 2020)** who had nearly two-thirds of patients in the cooled cap group (study group) had (grade 0, 1). This may be due to the variation in the type of cooling system, cooling time and cooling temperature variation in the chemotherapy (type, dose, time of infusion), or variation in the patient himself as a type of hair and age.

Part III: Side effect of cooling cap:

According to the findings of the present study, the prevalence of cooling cap side effects was: all of the study group suffered from feeling cold and the majority of them needed a blanket for warmth during this procedure. Also, all of them suffered from headaches and felt bored. In the same line, the result was reported by **(Shin, et al., 2015)** who reported that cooled cap patients (study group) suffered from headaches, bored, coldness, and uncomfortable sensations during the cooling cap procedure.

Also, in agreement with the study result done by **(Chan, et al.,2018)** who reported that the side effect of scalp cooling (study group) was almost all (SCG) suffered from pressure and tightness of scalp cooling caps, about half of them felt cold, and only one third need blanket for warmth, also another one-third suffering from headache and boredom. The result was also consistent with the study of **(Smetanay, et al., 2019)** who reported that the most common side effects of scalp coolers are headache, a cold sensation in the skin of the scalp, and shivering. These side effects were in general not serious. There were a few studies in which more than 10% of the patients' side effects were reasons for stopping the cooling procedure. This may be due to pressure and tightness of the scalp cooling caps which in the same instance lead to pain in the forehead leading to headache. Cooled caps temperature is kept below -25 during the time of procedure which may take more than 2 hours which leads to feeling cold and boring. Scalp cooling can be a long and uncomfortable procedure and should not be offered to patients unless it is very likely to be beneficial.

Part IV: Effectiveness of cooling cap on types of chemotherapy:

There is a significant improvement in alopecia in the study group (CCG) treated with Taxol-carpolinate compared to alopecia in the control group treated with the same drug as the majority- ty of women in study group SCG had (grade 1,2) hair loss while the majority of women in the control group have (grade 3,4) hair loss. There were also significant improvements in alopecia in the study group (CCG) treated with FAC (Flouruacil-Adriamycin Cyclo-phosphamide (Endoxan) compared to alopecia in the control group treated with the same drug as nearly more than half from the women in the study group (CCG) have grade 1 hair loss while in the control group, about two-thirds of the women have grade 4 hair loss. There were also, significant improvements in alopecia in the study group (CCG) treated with Flox compared to alopecia in the control group who were treated with the same drug as the majority of the women in the study group (CCG) have grade 1 hair loss while nearly more than half from the women in the control group have grade 3.

This shows that the quantity of hair loss is related to the type of chemotherapy as reported by the current study some medications lead to grade 4 hair loss as FAC and others lead to grade 3 hair loss as paclitaxel and Flox. This affects the result of the cooling cap as the medication that leads to grade 4 has improvement in most women while the medication that leads to grade 3 has improvement in the majority of women. This is due to the relation between the type of chemotherapy drug and its effect on hair.

This result is supported by the result of **(Bajpai, et al., 2020)** who found that there was a success rate in the majority of patients who were treated with the FAC regimen. Also confirmed the result reported that the success rate in almost all of the patients treated with docetaxel and in the majority of patients who were treated with paclitaxel but disagreed with him in the result of FAC that he found the success rate was only 8% of these patients.

Also, the result agreed with **(Marks, et al., 2019)** whose results reported that hair loss was avoided in all of the patients given doxorubicin treatment, while hair loss was avoided in the majority of patients given docetaxel treatment, and in about two-thirds of patients given FAC treatment, and also in about two-thirds of patients given docetaxel followed by FAC.

The findings also are in agreement with the result of the study done by the following authors **(Kinoshita et al., 2015),** who use doxorubicin, vincristine, fluorouracil, and methotrexate the hair is preserved in half in cooled caped patients (study group) while is preserved in less than quadrant in the control group who receive the routine hospital care, also **(Rugo, et al.,2017)** who used cyclo-phosphamide, fluorouracil, and methotrexate the hair is preserved in all cooled cape patients(study group) and less than quadrant in the control group who receive the routine hospital care.

Our results are also, in agreement with the study of **(Tew, et al., 2018)** who found a success rate in the majority of patients who were treated with taxanes and in all patients who were treated with Etoposoids or anthracyclines in scalp-cooled patients (study group).

Also, the result was supported by the result of **(Pokhrival, et al 2019)** who found a success rate in nearly all of the patients who were treated with docetaxel in the cooling cap group and in 5% in the control group who treated with the same treatment. Also, the result is consistent with **(Lee and chu, 2018)** who achieved a success rate in two-thirds of patients treated with FAC in the scalp cooling group while no patient in the control group preserved hair treated with the same treatment. This may be due to the variation in the chemotherapy type, dose and frequency of chemotherapy infusion, the type of scalp cooling equipment, and duration of scalp cooling itself.

In the current study, some patients were given paclitaxel, which has a longer infusion time than docetaxel. In addition, in the other studies anthracyclines and taxanes were given concomitantly, while in the present study, the patients received taxanes and anthracycline treatments sequentially. So, the mentioned differences in administration may affect the infusion time and might partly explain the differences in the results.

Part VI: The relation between demographic characteristics and grades of hair loss:

There was a statistically significance difference regarding alopecia in younger age women than older age women, the result of this study revealed that there was less hair loss in younger ages than in older age as all women whose ages ranged from (21 to 39) years old have grade 1 hair loss and nearly half from women aged from (40-49) have grade 1hair loss. Otherwise, nearly half of the women aged (50-60) have grade II hair loss and nearly half have grade 3, or 4, these results are consistent with **(Nangia, et al., 2017)** who also found that there was less hair loss in younger age than in older age. It is possibly due to that aged skin has a diminished cold-induced vasoconstriction and an age-related decline in organ function may increase toxicity leading to higher chemotherapeutic concentrations in hair root cells during scalp cooling. Chemotherapeutics mainly affect anagen hairs, i.e. hair in the growth phase, and cause a sharp constriction of the hair shaft, where hairs may break. Therefore, the reduced hair diameter at older age may also increase the risk of breakage.

Finally, based on the findings of the present study and most of the findings of the previous research, the cooling cap is effective in the prevention of alopecia in cancer patients undergoing chemotherapy, the effectiveness of the cooling cap depends on many factors as chemotherapy type, dose, and frequency, the cooling system (type, cooling time, and cooling duration) controlling.

Conclusion

Based on the findings of the present study, it could be concluded that:

The scalp cooling is effective in controlling chemotherapy-induced hair loss in cancer women scheduled to be treated with chemotherapy for the first time after curative surgery and free from metastasis while using Orbis Paxman cooling cap machine at -3Co, and when it was applied to the scalp half hour before starting chemotherapy, during chemotherapy and an hour after accomplishing chemotherapy.

Also, the degree of hair loss varied according to the type of chemotherapy regimen used in the treatment. There was less hair loss in younger age women than in older age women. The majority of patients tolerate cooling very well and side effect is not frequent and not serious.

Recommendation

Based upon the findings of the current study:

- Scalp cooling machines should be applied for cancer patients during chemotherapy cycles thus the cooling cap should be available in governmental and non-governmental hospitals.
- The women with cancer and undergone adjuvant chemotherapy should be encouraged to use cooling cap to reduce alopecia since the pharmacological intervention remains uncertain
- Further researches should be done to evaluate the effectiveness of Cooling Cap when using the combination chemotherapy with high doses and with a lot of chemotherapy cycles.
- Also research should be done to determine the extent of scalp skin metastasis while using the cooling cap.
- The following most important associated factors should be studied; post-infusion cooling time (PICT) which may imply shortening the discomfort and the extra time in the hospital following the chemotherapy cycle. Cooling cap research on a dose-response relationship (cooling temperature and time) needs to be conducted more efficiently. Also quality and growth of hair during and after cooling cap.

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