

Microvascular Free Flap: Effect of Nursing Teaching Protocol on Knowledge and Postoperative Complications for Patients Underwent Reconstruction of Lower Extremity

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Abstract

Background: Microsurgical free flap is widely used for the reconstruction of complex tissue defects, retrieval of anatomical structure, and improvement of function after debilitating injuries. **Aim:** Evaluate the effect of nursing teaching protocol on knowledge and postoperative complications for patients underwent microvascular free flap reconstruction of lower extremity. **Patients and Methods:** A quasi-experimental research design was used for a sample of 60 adult male and female patients, age ranged from 18-65 years old, underwent microvascular free flap reconstruction of lower extremity. They were randomly divided into 2 groups by flipping a coin [tails = control group (30 patients), heads= intervention group (30 patients)]. Nursing teaching protocol was applied to the intervention group (teaching booklet) while control group received routine hospital care. Patients were followed up for 6 months in trauma department and microvascular reconstruction outpatient clinic. Tool (I): Patient assessment sheet and Tool II: Modified claven–dindo classification. **Results:** Statistically significant difference between patients in intervention and control groups regarding patients' knowledge (p.value=0.001) and postoperative complications during follow up [after three weeks (P.value =0.02), three months (P.value =0.01), and six months (P.value =0.03)]. Improvement was obvious in intervention group than control group. **Conclusion:** Application of nursing teaching protocol showed obvious and significant effect in increasing patients' knowledge and reducing postoperative complications. **Recommendation:** To achieve the best patient outcomes, nurses must provide attentive nursing care for patients and nursing teaching booklet should be accessible in the microvascular unit for those patients.

Keywords: *Microvascular free flap, Nursing teaching protocol, Patients' knowledge, Postoperative complications & Reconstruction of lower extremity.*

Introduction

Free flap reconstruction may be required for composite defects after trauma, infection, wound healing problems, or oncological resection. Here, tissue is transferred to different parts of the body, and the arterial inflow and venous drainage are provided by vascular anastomoses (McGhee et al., 2017).

Microvascular free flap surgery is performed to restore shape and function in patients who experience extensive tissue defects after trauma, infection, or impaired wound healing, burns, and tumor resection. Many varieties of flaps can be used in order to restore soft tissue coverage, muscular function, and bone defects. Advances in microsurgery allow reconstructive with precise and patient-specific reconstructive approaches. Maintaining adequate perfusion of free flap tissue is vitally important for flap survival (Xiong et al., 2016) & (Schmidt et al., 2019).

Postoperative complications may include flap loss, partial or total necrosis, hematoma and sarcoma collections (for which the use of a post-operative

drain is not uncommon), wound dehiscence and infection, and a need for additional surgical interventions. Donor site morbidity should be negligible but involve a reduction in function, particularly in flaps involving muscle components (Abouarab et al., 2018).

When orthopedic surgeons planning for lower extremity microvascular reconstruction they must take into consideration the higher hazards that are present in area compared to other areas; lower limbs vascular network can be impacted by diabetes or peripheral vascular disease, and also by the fact that the area bears weight. Most of the lower extremities skin is thin and tight and covers muscles and, occasionally, bones directly (Cho et al., 2018).

Nurses play a crucial role for patients undergoing reconstruction of lower extremity. Preoperatively, the nurse should carefully assess the patient's condition, review the findings of diagnostic tests, and instruct patients about breathing and lower limb exercises that help prevent postoperative complications, such as pneumonia and deep vein thrombosis, that can arise after surgery. The nurse trains patients on how to

perform breathing and coughing exercises. Postoperatively, the nurse provides routine care for monitoring vital signs and urine output in addition to specialized care such as postoperative flap monitoring (color, temperature, turgor, capillary refill), pulse oximetry and assistance with flap wound dressing (Gutenbrunner et al., 2021).

Postoperatively, it is critical for nurses and the surgeon to closely monitor the flap. Blood supply loss can be treated surgically or medically if detected early. Monitoring postoperative flap circulation is critical to the success of free flap transfer. Changes in perfusion need to be recognized quickly to correct any treatable problems. Disruption of perfusion to a flap can lead to partial or complete flap loss. Flap monitored every 30 min first 3 hours, every 1 hour up to 48 hours, every 2 hours up to 72 hours after the surgery and then 4–8 hours until hospital discharge (Hosein et al., 2016; Lovčínková et al., 2020).

Significance of the study

The incidence of microvascular lower limb free flap in microvascular reconstruction unit at Assiut University Hospitals, (2021), approximately 90 cases during the period from January 2021 to December 2021. According to various studies, it has been revealed that those patients suffer several postoperative problems as a result of lack of awareness regarding the nursing instructions needed to reduce complications, which results in longer hospital stays and more expensive healthcare. Hence, this study focused on an attempt to apply nursing teaching protocol intended to improve patients' knowledge and reduce postoperative complications in those patients.

Aims of the study

- Assess level of knowledge for patients regarding microvascular free flap reconstruction of lower extremity.
- Develop and implement nursing teaching protocol for patients underwent microvascular free flap reconstruction of lower extremity.
- Evaluate the effect of implementing nursing teaching protocol on patients' knowledge and postoperative complications.

Research Hypotheses

- The post mean knowledge scores of intervention group patients will be higher than the control group patients.
- Intervention group patients will report fewer complications than control group patients.

Patients and Methods

Research design:

A quasi-experimental research design was utilized to conduct this study.

Study variables

The independent variable was nursing teaching protocol, while the dependent variables were the knowledge and complications of patients following microvascular free flap reconstruction of lower extremity.

Setting:

This study was conducted at the trauma department, microvascular reconstruction unit, and outpatient clinic at Assiut University Hospitals.

Sample:

A sample of 60 patients (female and male), whose age ranged from 18-65 years old, underwent microvascular free flap reconstruction of lower extremity. They were randomly divided into 2 groups by flipping a coin [tails = control group (30 patients), heads= intervention group (30 patients)]. Nursing teaching protocol was applied to the intervention group (teaching booklet), while the control group received routine hospital care. Patients with a history of vascular disease or diabetes mellitus were not involved in this study. Patients were followed up for 6 months in trauma department and the microvascular reconstruction outpatient clinic.

Sample size: According to G power software estimated "60" patients (with 30 in each group). For assessing differences between two independent means, a sample size was generated. Effect size (0.8), power (95%) and error (0.05).

Study tools:

Tool (I): Patient assessment sheet:

This tool consisted of three parts to assess patients' condition:

Part (1): Demographic data: Age, sex, level of education, personal habit (smoking), marital status, and occupation.

Part (2): Medical data: It included medical diagnosis and assessment of free flap.

Part (3): Patients' knowledge about microvascular free flap reconstruction of lower extremity: This part assessed the patients' knowledge regarding free flap, preoperative preparations that done before microvascular free flap, care of flap and donor site, potential complications postoperatively, time and how to start mobilization, time for returning to daily activities, follow-up and plan care that includes lower-limb exercises and teaching about a balanced diet after discharge from hospital.

Scoring system of tool I (part 3)

This part consisted of thirteen open ended questions. Correct and wrong answers were scored as 1 and 0 respectively, a total score ranged from 0 to 13. Patients who obtained less than 50% were considered having low level of knowledge, and patients who obtained score from 50% to 70% were considered having a moderate level of knowledge. While those

who obtained more than 70% were considered having a high level of knowledge.

Tool II: A modified clavien–dindo classification:

The Clavien–Dindo Classification is a standardized system for the registration of surgical complications. The classification was initially developed by **Clavien et al., (1992)** and was modified by **Dindo et al., (2004)** to increase its accuracy and acceptability in clinical practice. This scale consists of five grades to monitor postoperative complications for patients after microvascular free flap.

Scoring system of tool II

Grade I was defined as any deviation from the normal postoperative course without requiring medication, surgical, radiological, or endoscopic interventions. Analgesics, antipyretics, diuretics, antiemetic, and bedside wound care are all acceptable regimens. Grade II complications are those that need pharmacological therapy with medications other than those that are allowed for grade I complications. Grade III, which was initially categorized into grades IIIa and IIIb depending on whether the intervention was carried out under general anesthesia, was initially described as surgical complications requiring surgical, endoscopic, or radiological intervention. Grade IV was characterized as a life-threatening complication that requires therapy with high dependency and was further divided into grades IVa and IVb depending on single or multiple organ dysfunction.

Content validity:

Content validity was reviewed by five expertise (one orthopedic surgeon and four staff members from the field of medical-surgical nursing) who evaluated the tools for simplicity, relevance, comprehensiveness, and applicability.

Reliability of the used tool:

The reliability for a modified clavien–dindo classification (tool II) was evaluated by Cohen Kappa (0.95).

Pilot study

It conducted on 10% (three patients) from each group with lower limb defects recommended to be managed by microvascular free flap reconstruction of lower extremity at Assiut University Hospitals to ensure the applicability and clarity of the tools. The findings of the pilot study were analyzed and the necessary modifications were made. The current study sample did not contain any of the participants from the pilot study.

Ethical considerations:

Before conducting the study, ethical approval from the Ethical Committee in the Faculty of Nursing at Assiut University was obtained with approved number (1120230297) on 25 November 2021 and

also official permission from the head of the trauma department to collect data. Verbal consent was obtained to participate in this study after explaining the objectives and scope of the research. There was no risk for the study subjects during the application of the research; the privacy, anonymity, and confidentiality of the studied patients were assured by the researchers. The researchers emphasized to the participants that this study was voluntary and that they had the freedom to discontinue at any moment without giving any reason.

Procedure:

- Data for the current study was gathered between the beginning of February 2022 and the end of October 2022. In addition, both groups of patients continued postoperative follow-up for six months, which finished in April 2023.
- The nursing teaching protocol (teaching booklet) and data collection tools were prepared utilizing articles, books, periodicals, magazines, and variety literature in the various elements of this study. The researchers prepared and evaluated teaching places, teaching media, and aids as (pictures, demonstrations, and handout) to assist and improve the application of nursing teaching protocol for those patients.
- Before beginning to gather data, the researchers greeted patients, introduced themselves, provided a brief overview, and explained the objectives of the study.
- The researchers communicated with every patient individually.
- The researchers gathered baseline preoperative data through individual interview with each patient by using tools I.
- The control group received routine hospital care while the intervention group received routine hospital care in addition to a fully clarified description of the nursing teaching protocol, and a copy of the written teaching booklet was given to every patient in the intervention group (each patient in the intervention group was met for three sessions). Each session (30 to 40 minutes) included five minutes for clarification and respond to inquiries. The morning and afternoon shifts were selected for the sessions. One family member was allowed to attend the sessions as a way to assure patient support.

Nursing teaching protocol for patients underwent microvascular free flap reconstruction of lower extremity (teaching booklet):

It was designed by the researchers in a clear Arabic form, guided by various literatures (national and international) **Cho et al., (2018)** and **Kleban et al., (2020)** based on patient needs and recommendations

from medical and nursing expertise to enhance and increase patients' knowledge and reduce complications for patients underwent microvascular free flap reconstruction of lower extremity. It consisted of:

- Overview about microvascular free flap reconstruction of lower extremity, their benefits, a brief explanation of potential complications after surgery. preoperative instructions about relaxation technique such as coughing and breathing exercises, pin tract care, infection prevention, and warning sign of pin tract infection and specific care about the affected limb.
- Preoperative preparations before microvascular free flap reconstruction of lower extremity included assessment, diagnostic study, history of adverse reaction to anesthesia, risk factors that might affect the healing such as nutritional deficiencies, metabolic disease such as diabetes mellitus, steroid use, radiation or chemotherapy, drug or alcohol abuse, smoking cessation, wound debridement, and skin preparation for donor and affected site.
- Postoperatively, care and teaching included monitoring vital signs, intake and output, monitoring free flap, potential complications, and teaching patients about flap and donor site care, moving ankles and toes to prevent thrombus formation, practicing breathing exercises, time and how to start mobilization, time for returning to daily activities, follow-up and planning care that includes lower-limb exercises, a balanced diet, medication, personal hygiene an alternative approach to alleviating pain, pin tract care after discharge from the hospital.
- All patients in both groups were followed up for a period of 6 months postoperatively. Patients' knowledge (tool I, part III) evaluated before discharge, after 3 weeks, after 3 months, and after 6 months postoperatively. Also, postoperatively complications (tool II: modified clavien-dindo classification) were evaluated during immediate postoperative period, after 3 weeks, after 3 months, and after 6 months postoperatively. Patients were followed up by researchers during hospitalization and before discharge by attending to the trauma department and microvascular reconstruction unit. After discharge from hospital, patients were followed up by phone to follow their conditions.
- The researchers arranged with patients the time and place of follow up visits which conducted in the outpatient clinic of the trauma department and microvascular reconstruction unit after 3 weeks, after 3 months, and after 6 months postoperatively to evaluate patients' knowledge (tool I, part III) and postoperative complications (tool II: modified clavien-dindo classification).

Statistical design:

It was performed using SPSS version (26). As a way to compare the two groups demographic and medical data, independent t- test and chi-square tests were utilized. The frequency, percentage, mean, and standard deviation were used to present the data. For the purpose of testing the research hypotheses, a significance level of 0.05 was used. For analysing relationships between quantitative variables utilize the anova test.

Results

Table (1): Frequency distribution between (intervention and control) groups regarding demographic characteristics, medical diagnosis, and smoking (n=60)

Variables		Groups				P.value
		Intervention (n=30)		Control (n=30)		
		N	%	N	%	
Age	20<40 years	23	76.6	24	80.0	P=.137 ^{NS}
	40<60 years	7	23.3	3	10.0	
	60<65 years	0	0.0	3	10.0	
Sex	Male	30	100.0	27	90.0	P=.119 ^{NS}
	Female	0	0.0	3	10.0	
Level of education	Illiterate	2	6.7	6	20.0	P=.330 ^{NS}
	Write and Read	6	20.0	6	20.0	
	Secondary education	19	63.3	17	56.7	
	High education	3	10.0	1	3.3	
Occupation	Working	23	76.7	22	60.0	P=.046 ^{NS}
	Not-working	7	23.3	9	30.0	
Medical diagnosis	Open fracture grade III tibia & fibula	15	50.0%	17	56.7	0.840 ^{NS}
	Open fracture grade III femur and tibia & fibula	2	6.7	3	10.0	
	Dorsum of the foot crushed, ankle fractured	10	33.3	7	23.3	
	(lacerated wound) on the left thigh	3	10.0	3	10.0	
Personal habit (smoking)	Yes	19	63.3	14	46.7	0.150 ^{NS}
	No	11	36.7	16	53.3	

Chi square test

NS: no statistical significant difference P. value > 0.05

Table (2): Comparison among studied groups regarding patients' knowledge about microvascular free flap reconstruction of lower extremity (n=60)

Patients' knowledge (total score = 13)	Intervention group (n=30)	Control group (n=30)	P.value
	Mean ±SD	Mean ±SD	
Preoperative	1.46 ± 0.93	0.93±0.78	0.20 ^{NS}
Before discharge	12.40 ± 0.62	2.86 ± 0.77	0.001**
After 3 weeks	12.40 ± 0.62	2.86 ± 0.77	0.001**
After 3 months	11.83 ± 1.01	3.46± 1.00	0.001**
After 6 months	11.83 ± 1.17	2.86± 0.77	0.001**

- SD- standard deviation

- Independent t- test

* Significant level at P. value < 0.05

**Significant level at P. value < 0.01

- NS: no statistical significant difference P. value > 0.05

Table (3): Comparison among studied groups patients regarding compromised or healthy flap (n=60)

	Variables		Postoperative								X2	P. value
			Immediate		After 3 weeks		After 3 months		After 6 months			
			Groups		Groups		Groups		Groups			
			Intervention (n=30)	Control (n=30)	Intervention (n=30)	Control (n=30)	Intervention (n=30)	Control (n=30)	Intervention (n=30)	Control (n=30)		
Skin color	Well-perfused, pink	N	30	28	30	28	30	30	30	30	4.13	0.24 ^{NS}
		%	100.0	93.3	100.0	93.3	100.0	100.0	100.0	100.0		
	Dusky, Purple/ blue	N	-	2	-	2	-	0	-	0	-	-
		%	-	6.7	-	6.7	-	0	-	0		
Capillary refill	2-3 seconds	N	30	28	30	28	30	30	30	30	4.13	0.24 ^{NS}
		%	100.0	93.3	100.0	93.3	100.0	100.0	100.0	100.0		
	More 6 second/ absent (Arterial insufficiency)	N	-	2	-	2	-	0	-	0	-	-
		%	-	6.7	-	6.7	-	0	-	0		
Skin Turgidity	Soft	N	30	28	30	28	30	30	30	30	4.13	0.24 ^{NS}
		%	100.0	93.3	100.0	93.3	100.0	100.0	100.0	100.0		
	Stretched, swollen	N	-	2	-	2	-	0	-	0	-	-
		%	-	6.7	-	6.7	-	0.00	-	0.00		
Temperature	Warm	N	30	28	30	28	-	30	30	30	4.13	0.24 ^{NS}
		%	100.0	93.3	100.0	93.3	-	100.0	100.0	100.0		
	Cold	N	-	2	-	2	-	0	-	0	-	-
		%	-	6.7	-	6.7	-	0	-	0		
Pin-prick Test	Healthy flap 1:2 drop of blood	N	30	28	30	28	-	30	30	30	4.13	0.24 ^{NS}
		%	100.0	93.3	100.0	93.3	-	100.0	100.0	100.0		
	"Venous congestion" rapid exit of dark red blood	N	-	2	-	2	-	0	-	0	-	-
		%	-	6.7	-	6.7	-	0	-	0		

Chi square test

NS: no statistical significant difference P. value > 0.05

Table (4): Comparison between control and intervention groups regarding modified clavien–dindo classification of surgical complications (n=60)

Grade	Modified Clavien–Dindo Classification of surgical complications															
	Immediate Postoperative				After 3 weeks				After 3 months				After 6 months			
	Intervention group (n=30)		Control Group (n=30)		Intervention group(n=30)		Control Group (n=30)		Intervention group n=30)		Control Group(n=30)		Intervention group (n=30)		Control group (n=30)	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Grade I Pin site infection swelling	2	6.7	0	0.0	2	6.7	9	30.0	0	0.0	4	13.3	0	0.0	0	0.0
Delay wound healing	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3	10.0	0	0.0	1	3.3
Grade II Bleeding	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Grade IIIa Joint stiffness	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	3.3	0	0.0	1	3.3
Necrosis of toes	0	0.0	0	0.0	0	0.0	1	3.3	0	0.0	0	0.0	0	0.0	0	0.0
Grade IIIb Partial or total free flap failure.	0	0.0	2	6.7	0	0.0	2	6.7	0	0.0	0	0.0	0	0.0	0	0.0
P. value	0.135^{NS}				0.02^{**}				0.01^{**}				0.03^{**}			

Chi square test *Significant level at P. value < 0.05 **Significant level at P. value < 0.01 - NS: no statistical significant difference p. value > 0.0

Table (5): Relationship between age, smoking and postoperative free flap complications between intervention and control groups (n=60)

Demographic data		No complication				Grade I				Grade III				Grade IIIc				P. value
		Intervention group (n=30)		Control Group (n=30)		Intervention group (n=30)		Control group (n=30)		Intervention group (n=30)		Control group(n=30)		Intervention group (n=30)		Control Group (n=30)		
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	
Age	20<40 years old	20	66.7	17	56.7	2	6.7	6	20.0	0	0.0	0	0.0	0	0.0	1	3.3	0.02*
	40<60 years old	8	26.7	0	0.0	0	0.0	2	6.7	0	0.0	0	0.0	0	0.0	1	3.3	
	60<65 years old	0	0.0	1	3.3	0	0.0	1	3.3	0	0.0	1	3.3	0	0.0	0	0.0	
Personal Habit (Smoking)	Yes	0	0.0	3	10.0	0	0.0	6	20.0	0	0.0	1	3.3	0	0.0	2	6.7	0.01*
	No	28	93.3	15	50.0	2	6.7	3	10.0	0	0.0	0	0.00	0	0.0	0	0.00	

Chi square test *Significant level at P. value < 0.05

**Significant level at P. value < 0.01

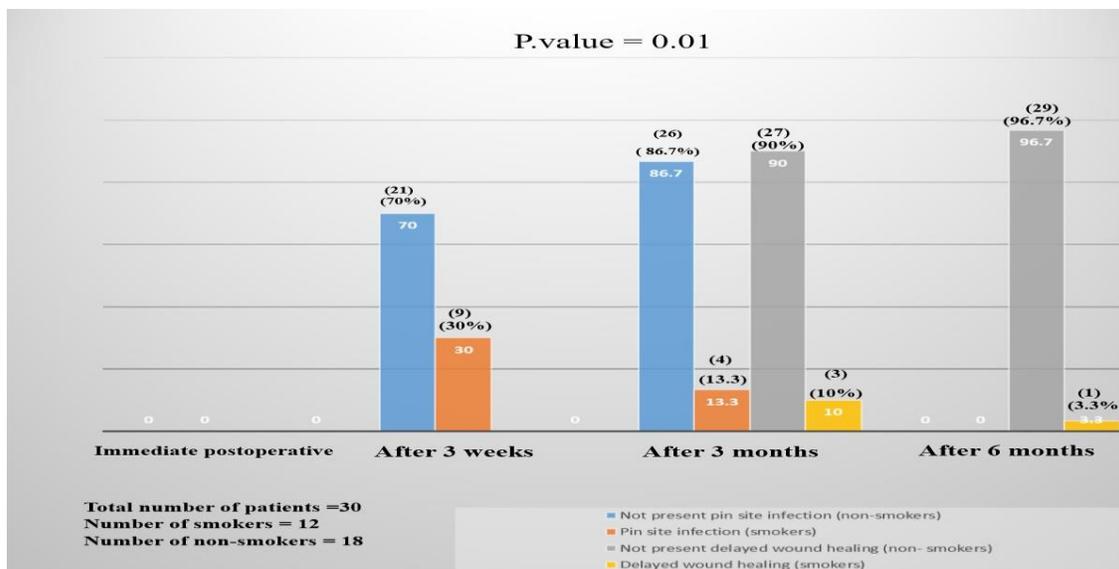


Figure (1): Relationship between pin site infection, delayed wound healing and smoking among control group patients

Table (6): Relationship between postoperative free flap complications and patients’ knowledge among patients of intervention and control groups (n=60)

	Follow up	Intervention group (n=30)	Control Group (n=30)	P. value
		Mean ± SD	Mean ± SD	
Total patients’ knowledge (total score = 13)	After 3 weeks	12.40 ± 0.62	2.86 ± 0.77	0.01**
Postoperative free flap complications		1.06 ± 0.25	1.80±1.56	
Total patients’ knowledge (total score = 13)	After 3 months	11.83 ± 1.01	3.46± 1.00	0.01**
Postoperative free flap complications		1.00 ± 0.00	1.50±1.07	
Total patients’ knowledge (total score = 13)	After 6 months	11.83 ± 1.17	2.86 ± 0.77	0.01**
Postoperative free flap complications		1.00 ± 0.00	1.13±0.57	

ANOVA test

*Significant level at P. value < 0.05

SD- standard deviation

**Significant level at P. value < 0.01

Table (1): Shows that more than two third of the intervention and control groups (76.6%, 80.0% respectively), their age ranged from (20 < 40) years. Regarding sex, 30 (100%) of patients in the intervention group and 27 (90%) most of the control group were males, and more than half in intervention and study groups had secondary education (63.3%, 56.7% respectively) and working (76.7% 60.0% respectively). Half of intervention group (50.0%) and more than half (56.7%) of control group had open fractures grade III of the combined tibia and fibula. More than half (63.3%) in the intervention group and more than one third (46.7%) in the control group were smokers.

Table (2): This table shows that there was non-statistically significant difference between both groups regarding preoperative patients’ knowledge

about microvascular free flap reconstruction of lower extremity (p. value=0.20). Highly statistically significant difference was found between the intervention and control groups regarding patients’ knowledge before discharge and after 3 weeks, 3 months, and 6 months (p. value= 0.001). Intervention group patients showed greater improvement in their knowledge after implementation of nursing teaching protocol than the control group.

Table (3): Clarifies that non- statistically significant difference was found in both groups regarding healthy or compromised flaps (p. value > 0.05). Fewer percent (6.7%) of the control group were dusky and blue in skin color, stretched and swollen in skin turgidity, cold skin, and venous congestion, with rapid exit of dark red blood with a pin-prick test.

Table (4): Demonstrates that there was a non-

statistical significant difference between the control and intervention groups (P . value > 0.05) regarding immediate postoperative complications. There were statistically significant differences between control and intervention groups regarding postoperative free flap complications during follow-up (3 weeks, 3 months, and 6 months) (P . value =0.02) (P . value =0.01) (P . value =0.03) respectively. The commonest postoperative complications in the control group were categorized into grade I (4 patients, 13.3%) delayed wound healing, (13 patients, 21.9%) pin site infection, grade IIIa (2 patients, 6.6%) joint stiffness, (1 patient, 3.3%) necrosis of toes, and grade IIIb (4 patients, 13.3%) total free flap failure. Intervention group had less postoperative complications (4 patients, 13.3%) pin site infection.

Table (5): This table shows that statistically significant relationship between age, smoking and postoperative free flap complications (p . value=0.02, p . value=0.01 respectively). Non- smokers showed less postoperative complications than smokers. Young and middle aged showed less postoperative complications than old adult.

Figure (1): Illustrates that a statistical significant relationship (p . value = 0.01) between pin site infection, delayed wound healing and smoking. Pin site infection and delayed wound healing were obvious in smokers than non-smokers.

Table (6): This table shows that there was statistically significant relationship between postoperative free flap complications and patients' knowledge among patients of intervention and control groups during follow up (after 3 weeks, 3 months, and 6 months) (p .value= 0.01). Intervention group patients showed greater improvement in their knowledge led to less postoperative complications compared to the control group during follow-up (after 3 weeks, 3 months, and 6 months) after implementation of the nursing teaching protocol.

Discussion

Microvascular free flap reconstruction has revolutionized the restoration of complex defects of traumatic, congenital, oncological, and infectious diseases. Complications of microvascular free flap procedures impact negatively on the patient's postoperative course as well as outcome (Dolan et al., 2012).

The current study showed that more than two-thirds of the studied group patients age ranged from twenty to less than forty years. This current study finding was consistent with a study conducted by Alam et al., (2020) who reported that the mean age was (34 ± 11) years for patients who underwent a microsurgical free flap.

Regard to age, the current study reported that the

majority of both groups of patients were males. Similar to the current study Arslan & Demiroz (2019) who confirmed that free flap reconstruction was performed for reconstruction lower limb in six females and twenty-nine males. The average age was thirty-and-a-half years.

The present study revealed that more than half of the studied groups patients was working. This result was supported by Khorais et al., (2018) who stated that more than half of both groups were manual workers.

The present study showed that about half of the intervention group and more than half of control group had open fractures in grade III of the combined tibia and fibula. This study finding was consistent with a study of Mohammed et al., (2017) who conducted on patients with open lower extremity fractures and reported that the most common diagnosis among the studied patients was an open tibia and fibular fracture.

The present study showed a statistical significant difference between intervention and control groups regarding patients' knowledge during follow up. Intervention group showed significant improvement in their knowledge before discharge, after three weeks, three months and six months postoperatively than control group. Both groups showed lack of knowledge at the time of assessment (perioperative period).

From the researchers point of view, lack of knowledge for both groups at the time of assessment might be due to that patients did not receive enough information about their conditions. Improvement in knowledge of intervention group patients during follow up period could be due to the effect of the nursing teaching protocol (teaching booklet) which developed by researchers to improve patients' knowledge about their care and minimize postoperative complications.

Inconsistent with the current study, study of Sayed et al., (2023) reported that patients are in essential need for sufficient information about their conditions; preoperative and postoperative care to improve their outcomes. Sufficient knowledge led to adequate self-care management and thus improving patients' outcomes.

Regard to healthy or compromised flap assessment, the present study reported no compromised flaps among patients in the intervention group, while it was found that only four patients out of thirty in the control group had developed venous obstructions of the flap, which were characterized by dusky and blue in skin color, stretched and swollen in skin turgidity, cold skin, and venous congestion, with rapid exit of dark red blood with a pin-prick test.

From the researchers point of view, this could be due to the effect of nursing teaching protocol (teaching

booklet) on improving knowledge of the intervention group patients about care of the flap site, warning signs and symptoms of venous congestion, and risk factors for flap failure.

Similar to the present study of **Sayed et al., (2009)** who conducted on thirty patients with microvascular free flap and reported that only one patient out of thirty had developed venous obstructions of flap was the main features by white color, coldness, sponginess, capillary refill lasting longer than six seconds, and no bleeding when tested with a pin prick after provided teaching protocol.

Also, similar to the current finding, a study conducted by **Kleban et al., (2020)** clarified that qualified nurses improved the quality of information regarding venous congestion, capillary refill monitoring, and underlying physiology of the microsurgical free flap led to increased flap survival rates.

The present study revealed that the majority of the intervention group patients had a good level of knowledge regarding the care and instructions that should be followed before and after microvascular free flap reconstruction of lower extremity to prevent infection and complications after implementation of the nursing teaching protocol.

This study findings are in the same line with study of **Khan et al., (2010)** who confirmed that following postoperative flap teaching program, knowledge of the studied patients improved with obvious improvement in understanding of flap care.

The present study showed that, highly statistical significant difference was found between both groups regarding patients' knowledge before discharge and after three weeks, three months, and six months postoperatively. Intervention group patients showed greater improvement in their knowledge after implementation of nursing teaching protocol.

Similar to current study finding a study conducted by **Matt-Hensrud et al., (2015)** stated that there was a statistical significant improvement in patients' knowledge during the three months following participation in discharge planning education.

The present study result shows that there was statistical significant difference between the intervention and control groups regarding postoperative free flap complications during follow-up (Immediate postoperative, after three weeks, three months, and six months). Commonest postoperative complications in the control group were categorized into grade I delayed wound healing, pin site infection, grade IIIa joint stiffness, necrosis of toes, and grade IIIb total free flap failure.

This could have explained that, the intervention group had less postoperative complications after implementation of nursing teaching protocol compared to the control group during follow up

(Immediate postoperative, after three weeks, three months, and six months).

This study finding was supported by **Pu (2017)** who found that no flap loss, either partial or total, had occurred. From the researchers point of view, immediate postoperative care and additional follow-up care and instructions are all necessary to guarantee the success of free-tissue transfer to the lower leg.

The current study demonstrates that, only four of intervention group patients developed grade I pin site infection. From the researchers point of view, this could be due to the effect of nursing teaching protocol (teaching booklet) for intervention group which has a significant and obvious effect in improving patients' knowledge about pin site care, warning signs of infection and specific care about the affected extremity. Additionally, continuous follow up by the researchers to ensure patients' commitment to the instructions regarding adequate nutrition, rest, hygiene, and range of motion to promote circulation of lower limbs.

This study result was supported with a study conducted by **Lee et al., (2012)** who revealed that only eleven patients developed pin site infection, whose categorized was grade I and II, no deep infections occurred.

The present study revealed that there was a highly statistical significant relationship between flap failure and smoking. Improvement of patients' knowledge (intervention group) regarding smoking cessation and the effect of smoking on decreased oxygenation of wound tissue and nicotine-produced narrowing of blood vessels that may lead to flap failure. In addition, patients' commitment to smoking cessation led to decrease risk of flap failure compared to the control group after implementation of the nursing teaching protocol. This study finding was congruent with **Hwang et al., (2018)** who found that flap loss rate was significantly higher in smokers than non-smokers.

Also, this finding matches with **Ekin et al., (2019)** who mentioned that there was significant relationship between age, co- morbidity and flap loss.

The current study finding revealed that there was statistical significant relationship between pin site infection, delayed wound healing and smoking. From the researchers point of view, this could be due to the effect of nursing teaching protocol (teaching booklet) for intervention group which has a significant and obvious effect in improving patients' knowledge about instructions regarding smoking cessation because smoking reduces oxygen pressure in the alveoli and smoking has been shown to decrease subcutaneous collagen of wound tissue, although nicotine narrows blood vessels supply to wound.

This study finding was supported by **Fan et al., (2023)** who conducted study entitled "Smoking increases the risk of postoperative wound complications" which revealed that smokers suffered from delayed wound healing than non-smokers.

This finding matches with study of **Shah et al., (2014)** who reported that smoking was significantly associated with deep wound infection.

Also, study of **Liu et al., (2021)** mentioned that smoking was a significant risk factors for pin tract infection with unilateral external fixation.

The present study finding showed that there was a highly statistical significant relationship between patients' knowledge and postoperative complications. Intervention group patients showed greater improvement in their knowledge led to less postoperative complications compared to the control group during follow-up after three weeks, three months, and six months.

From the researchers point of view, this could be due to the effect of nursing teaching protocol (teaching booklet) for the intervention group, which led to improving patients' knowledge about free flap site care, potential reconstruction lower extremity complications, signs and symptoms of flap failure, care of the donor site, postoperative mobilization following lower limb free flap reconstruction, strength of the lower extremities musculature, alleviating pain, pin tract care, and infection prevention. Additionally, the researchers continuously follow up patients to ensure that they are committed to the instructions regarding the treatment plan and follow-up care, as education regarding a healthy diet, activities of daily living, practicing relaxation techniques, including breathing exercises, and maintaining range of motion in the lower extremity to promote circulation of lower limb.

This finding matches with study of **Zhao et al., (2021)** who supported the current study finding, the study conducted on one hundred-fourth patients undergoing microvascular free skin flap to evaluate the impact of implemented nursing management on reducing postoperative complications and the results showed that the study group patients had reduce the risk of postoperative complications and improved self-care skills.

Conclusion

Based on the findings of the current study, it can be concluded that intervention group patients who received nursing teaching protocol (teaching booklet) following microvascular free flap reconstruction of lower extremity achieved significant improvement in patients' knowledge and less postoperative complications. Improving patients' knowledge led to fewer postoperative complications for patients underwent microvascular free flap reconstruction of

lower extremity.

Recommendations

The present study recommends the following:

1. Simple written teaching booklet should be accessible for patients with simple instructions about preoperative and postoperative care is of great importance for patients underwent microvascular free flap reconstruction of lower extremity.
2. Periodic assessment of nurses' knowledge and practice in trauma department and microvascular reconstruction unit about preoperative and postoperative nursing care among patients and the necessary teaching and instructions that are provided to patients before discharge.

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