Dietary management of surgical patients: effects on incisional wound healing

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التدبير الغذائي لمرضى الجراحة وآثاره على إلتئام شقوق الجراحة

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خلاصة : أجريت بالمستشفى الرئيسي الجامعي بالإسكندرية ، دراسة على عيّنة من 38 مريضاً ـ تم تقسيمهم إلى مجموعة شاهدة ومجموعة تجريبية . ودلت نتائج البحـــث على وجود فوارق ذات دلالة إحصائية بين المجموعتين في مستوى التعليم ، ولكن لم تظهر أية فوارق في صورة الدم أو منْسَب كتلة الجسم أو الحالة التغذوية . وقد لوحظ اختلاف في سرعة التئام الجروح بين المجموعتين ، ووجدت علاقة بين الحالة التغذوية والتئام الجروح في المجموعة الشاهدة . وكانت مدة الإقامة الكلية للمجموعة الشاهدة أطول من مثيلتها بالنسبة للمجموعة التجريبية . وبناء على ذلك يوصى بضرورة تقييم الحالة التغذوية لمرضى الجراحة ومدخولهم من الطعام على فترات متقاربة قبل الجراحة وبعدها .

ABSTRACT A study of 38 patients was undertaken at the main University Hospital in Alexandria. The sample was divided into a control group and an experimental group. Findings show statistically significant differences between the two groups in the level of education, but no difference in blood picture, body mass index or nutritional status. There was a difference in the rate of wound healing in the two groups, and a relationship between the nutritional status and wound healing in the control group. Total hospital stays for the control group were longer than those for the experimental group. The nutritional status of surgical patients, as well as their food intake, should be evaluated at short intervals before and after surgery.

Prise en charge diététique des patients opérés: effets sur la cicatrisation des plaies chirurgicales

RESUME Cette étude a été entreprise à l'hôpital universitaire principal d'Alexandrie. L'échantillon comportait 38 patients divisés en deux groupes - un groupe témoin et un groupe expérimental. Les résultats montrent des différences statistiquement significatives entre les deux groupes, en particulier dans le niveau d'instruction, mais aucune dans l'hémogramme, l'indice de masse corporelle ou l'état nutritionnel. Il y avait une différence dans le taux de cicatrisation des plaies observé chez ces deux groupes, et une relation entre l'état nutritionnel et la cicatrisation des plaies dans le groupe témoin. Le séjour total à l'hôpital était de plus longue durée pour le groupe témoin que pour le groupe expérimental. L'état nutritionnel des patients en chirurgie ainsi que leur régime alimentaire devraient être évalués à de brefs intervalles de temps avant et après l'intervention chirurgicale.

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Introduction

Nutritional care plays an important role in the success of surgery. Hospital stay may be avoided, wound healing enhanced and the number of complications reduced by adequate nutritional support [*1–4*]. Failure of wounds to heal, however, increases the financial, physical and emotional cost of hospitalization and increases the workload of health professionals [*5*].

Clean surgical incisions often heal by primary intention. However, one of the local factors which impede this process is infection. Systematically, healing depends on the delivery of blood with its supply of oxygen, nutrients and leukocytes to the wound site. Some specific conditions that impair healing include neoplasia, anaemia or vital systemic disease. Therefore, preoperative repletion, wound care and postoperative dietary supplements are essential for optimal repair [*5*].

Nutritional management is a coordinated effort of the medical, nursing and dietary staff. It entails thorough assessment of the preoperative and postoperative patient's dietary behaviour and intake, evaluation of nutritional state and providing patients with the appropriate instructions [*5,6*].

Available research data denote a lack of consistent standards of surgical dietary planning. Nutritional surveys are essential prerequisites in this regard, since they serve as scientific bases for subsequent dietary planning and interventions [*7,8*].

Aims and objectives

- To assess the general surgical patient's nutritional status and dietary intake.
- To design and implement individualized dietary plans based on the surgical patient's needs.
- To identify the effects of dietary management on incisional wound healing.

Materials and methods

This study was undertaken in the general surgical wards and the private wards at Alexandria main University Hospital. Thirty-eight general surgical patients were included in the sample. They were enrolled in succession into a control group ($n = 22$) then an experimental group ($n = 16$).

Criteria for subjects inclusion were: male and female preoperative adults with no associated medical disorders affecting their wound healing, expected to stay postoperatively to be watched for wound healing or at least to return after discharge for suture removal, and willing to participate in the study.

Tools

Tools used in the study were as follows.

1. Surgical patient nutritional and wound healing assessment sheet. This sheet, developed by the researchers, included the following main points:
   a) Patient personal characteristics: age, sex, diagnosis, type of surgery, as well as dates of admission, operative suture removal, healing and discharge.
   b) Preoperative laboratory investigations: haemoglobin percentage and white blood cell total count.
   c) Anthropometric measures: patient's weight (kilograms), height (metres), mid-arm circumference (MAC in centimetres) and triceps skin fold (TSF in millimetres) [*9,10*].

d) Patient's nutritional status: an estimation of the patient's preoperative weight as percentage of standard weight was calculated: (measured weight in kilograms ÷ standard weight × 100), to determine whether it was normal, i.e. between 90% and 100%, less than 90%, or more than 110%. Also, body mass index (BMI) was estimated (weight in kilograms ÷ height squared in square metres) to determine whether the subject was non-obese (< 25) or obese (> 25) [*9,10*].

e) Wound healing checklist: derived from Young [*11*] and adapted. It involved local and general criteria of inadequate wound healing. One score was allotted for each sign of redness, hotness, oedema, discharge and dehiscence. For the general criteria, one score was given for delay in suture removal and two scores for fever exceeding 38 °C, two days after surgery. Healing scores were thus calculated as a fraction (out of 8), with higher scores indicating poorer wound healing.

2. Preoperative and postoperative dietary intake record. This record was used to assess patients' dietary intake throughout the three days prior to and following surgery. A 24-hour diet recall was used. Dietary analysis was calculated thereafter using food composition tables [*12*], and averages were obtained.
3. Preoperative and postoperative meal plans. These dietary plans were designed individually for the experimental group subjects, based on the initial nutritional assessment, as well as the calculation of the surgical hospital patient's needs. The control group had the same meals as other surgical patients.
4. Preoperatively, nutritional support was geared to the correction of diet. Those patients found to need preoperative repletion received calories and proteins at levels 30% to 50% above maintenance. Minerals, vitamins and fluids required for normal good nutrition and hydration were also provided.
5. Postoperative plans were directed at increasing daily energy requirements to 10% or slightly more, provided that there were no complications. From 0.1g to a maximum of 0.2 g protein per kilogram of usual body weight were supplemented. The goal of this nutritional support was to provide anabolism with sufficient calories [*6*]. Further dietary vitamin supplements were also considered.
6. These plans involved three meals of alternative foods in ideal quantities deemed important and agreed upon by the attending surgeons and dietitians.

Procedure

Patients in the experimental group were matched with the controls, according to the age, sex and diagnosis variables. Medical and nursing interventions of both groups of subjects, including dressing, were approximately standardized in the study setting.

Patients in the control group were enrolled into the study first. Collecting the two groups at the same time would create bias, since experimental subjects and hospital staff could inadvertently inform the controls about dietary instructions.

Wound healing items were checked by ward surgeons, and dietary analysis was carried out by one of the investigators; in certain instances they were aware of the subjects' assigned group.

All patients were interviewed, 3 to 7 days prior to surgery, to review their medical records and laboratory studies, consult their treating surgeons and fill in the initial assessment sheets. Additionally, and daily thereafter, they were counselled about their 24-hour dietary intake. Throughout the subsequent 3 to 4 postoperative days, daily interviews were conducted to record the subjects' dietary intake. Their operative incisions were also checked for signs of wound healing during dressing change and/or suture removal. Compliance with the plans was emphasized during daily visits.

Table 1 **Characteristics of the sample**

Variable	Control group (n = 22) No.	%	Experimental group (n = 16) No.	%	Tests of significance
Age (years, mean ± s)	42.25 ± 14.17		41.73 ± 13.49		t = 0.7783 NS
Sex					
Male	12	54.5	11	68.8	$\chi^2 = 0.782$
Female	10	45.5	5	31.2	P = 0.37641 NS
Educational level					
Low (illiterate or reads and writes only)	22	100.0	7	43.8	$\chi^2 = 13.25$*
High (intermediate or higher)	0	0	9	56.2	P = 0.00007
Occupation					
Working (workers or employees)	11	50.0	13	81.2	$\chi^2 = 2.661$
Not working (housewives or retired)	11	50.0	3	18.8	P = 0.00027 NS
Marital status					
Single	3	13.6	2	12.5	FET = 0.01047
Married	19	86.4	14	87.5	P = 0.91851 NS
Type of surgery					
Splenectomy	8	36.4	2	12.5	$\chi^2 = 6.885$
Cholecystectomy	9	40.9	13	81.2	P = 0.076 NS
Abdominal mass	3	13.6	0	0.0	
Hernia repair	2	9.1	1	6.3	

**Significant at 0.05 level*
NS = not significant
FET = Fisher's exact test

Table 2 **Anthropometric measurements and nutritional status of subjects in both groups prior to surgery**

Group	MAC (cm) Mean ± *s*	TSF (cm) Mean ± *s*	BMI Mean ± *s*	Percentage of standard weight Mean ± *s*
Control ($n = 22$)	30.41 ± 5.76	24.64 ± 9.27	28.05 ± 6.34	105.79 ± 30.72
Experimental ($n = 16$)	32.00 ± 6.94	29.13 ± 11.85	26.60 ± 4.30	104.90 ± 21.93
t-value ($n - 16$)	0.771 NS	1.310 NS	0.786 NS	0.099 NS

NS = not significant

Statistical analysis

Data were analysed and tabulated. Absolute percentage and frequency distribution, means and standard deviations (*s*) were computed. Data obtained from the two study groups were compared using *t*, χ^2 and Fisher's exact tests. Simple correlation coefficients and regression coefficients were computed and multiple regression and *F*-tests performed to identify the relations and the collective effect of dietary variables and wound healing.

Table 3 **Blood picture of subjects in both groups prior to surgery**

Group	Haemoglobin (%) Mean ± *s*	WBC total count/m³ Mean ± *s*
Control ($n = 22$)	79.59 ± 7.51	5400 ± 1200
Experimental ($n = 16$)	82.94 ± 11.91	5340 ± 1060
t-value	1.062 NS	0.155 NS

NS = not significant

Results

The mean age of the experimental subjects was slightly lower than that of the controls (41.73 and 42.25 years, respectively, $t = 0.778$). No statistically significant differences were detected among subjects of the two groups regarding characteristics, except for education ($\chi^2 = 13.25$ and $P = 0.00007$) (Table 1).

As regards the nutritional status of the subjects prior to surgery, Table 2 shows that no statistically significant differences were observed between the two groups of subjects in any of the studied parameters, where *t*-values were 0.771 for MAC, 1.310 for TSF, 0.786 for BMI and 0.099 for percentage standard weight.

Routine blood picture prior to surgery revealed no statistically significant differences, since *t*-values for haemoglobin and white blood cells (WBCs) were 1.062 and 0.155, respectively (Table 3).

Table 4 shows the subjects' preoperative BMI and nutritional status in relation to wound healing. No statistically significant differences were found between the two groups ($\chi^2 = 0.037$ and 4.400, respec-

Table 4 **Subjects' preoperative body mass index and nutritional status in relation to wound healing**

Variable	Control (*n* = 22) No.	%	Experimental (*n* = 16) No.	%	Tests of significance
Body mass index					
< 25 (non-obese)	9	40.9	7	43.8	$\chi^2 = 0.037$
> 25 (obese)	13	59.1	9	56.2	$P = 0.860$ NS
Total	22	100	16	100	
Nutritional status					
Below normal (< 90)	10	45.5	4	25.0	$\chi^2 = 4.400$
Normal (90–110)	4	18.1	8	50.0	$P = 0.11078$ NS
Above normal (> 110)	8	36.4	4	25.0	
Total	22	100	16	100	
Wound healing					
Good	12	54.5	16	100	$\chi^2 = 7.665$*
Poor	10	45.4	0	0	$P < 0.05$
Total	22	100	16	100	

NS = not significant
**Significant at 0.05 level*

tively). All of the experimental subjects had good wound healing, compared to only 54.5% of the controls, and the difference was significant (χ^2 after correction was 7.665).

Ten of the controls (45.5%) experienced poor wound healing: two patients (20%) had incisional serious discharge, two (20%) had persistent fever (39 °C), and the rest (60%) had both discharge and fever; 50% were below normal in their nutritional status. Among 12 controls who had good wound healing, equal percentages (five individuals; 41.7% each) were either of below-normal or above-normal nutritional status and the remaining two (16.6%) were normal (Table 5).

Table 6 indicates that the control group subjects had significantly longer total hospital stay ($t = 3.165$) and a slightly delayed day of healing ($t = 1.435$). However, the experimental subjects had a significantly

Table 5 **Cross analysis of the nutritional status with operative wound healing in the control group subjects**

Nutritional status of control group (*n* = 22)	Wound healing: Good (*n* = 12) No.	%	Poor (*n* = 10) No.	%
Below normal (< 90)	5	41.7	5	50.0
Normal (90–110)	2	16.6	2	20.0
Above normal (> 110)	5	41.7	3	30.0

Table 6 **Comparison between the control and experimental group subjects regarding some studied variables**

Group	Total length of hospital stay (days)	Day of suture removal	Day of healing	Healing score
Control (Mean ± *s*) (*n* = 22)	28.32 ± 25.85	9.84 ± 2.81	15.06 ± 20.91	0.13 ± 0.19
Experimental (Mean ± *s*) (*n* = 16)	7.63 ± 3.76	11.00 ± 0.00	8.31 ± 5.52	0.0 ± 0.0
t-values	3.165*	0.401 (NS)	1.435 (NS)	2.675*

NS = not significant
**Significant at 0.05 level*

Table 7 **Average daily dietary intake of the control and experimental group subjects prior to surgery**

Dietary element	Control group (*n* = 22) Mean ± *s*	Experimental group (*n* = 16) Mean ± *s*	*t*-value
Caloric intake (Cal)	1167.55 ± 371.0	1014.25 ± 248.36	1.52 NS
Protein (g)	44.10 ± 9.17	40.92 ± 14.06	0.844 NS
Fat (g)	50.59 ± 78.07	32.92 ± 9.34	0.915 NS
Carbohydrate (g)	160.18 ± 57.35	139.50 ± 33.26	1.290 NS
Iron (mg)	7.74 ± 3.19	8.06 ± 5.07	0.235 NS
Calcium (mg)	183.91 ± 65.01	285.81 ± 51.26	2.8315*
Vitamin A (μg)	1651.55 ± 2099.45	4102.00 ± 3183.17	2.8660*
Thiamine (mg)	1.17 ± 1.66	0.66 ± 0.36	1.208 NS
Riboflavin (mg)	1.55 ± 2.06	1.06 ± 0.56	0.917 NS
Niacin (mg)	9.94 ± 8.26	6.28 ± 4.26	1.620 NS
Vitamin C (mg)	29.45 ± 15.70	38.88 ± 19.38	1.654 NS

NS = not significant
**Significant at 0.05 level*
N.B. Zinc was not included since the available zinc food composition tables were very limited

lower score of healing than their controls ($t = 2.675$), indicating better wound healing.

Preoperatively, the experimental group subjects' mean dietary intake of calcium and vitamin A was significantly higher than that of their controls ($t = 2.832$ and 2.866, respectively) (Table 7).

Similarly, in the postoperative stage, the mean values of dietary intake of proteins, iron, calcium, vitamin A and riboflavin among the experimental subjects were sig-

Table 8 **Average daily dietary intake of the control and experimental group subjects after surgery**

Dietary element	Control group (n = 22) Mean ± s	Experimental group (n = 22) Mean ± s	t-value
Caloric intake (Cal)	748.77 ± 258.13	894.44 ± 253.35	1.7307 NS
Protein (g)	30.90 ± 12.88	39.79 ± 12.57	2.1214*
Fat (g)	33.97 ± 38.72	57.12 ± 92.16	1.0606 NS
Carbohydrate (g)	133.95 ± 195.27	116.88 ± 42.07	0.3429 NS
Iron (mg)	3.85 ± 1.82	5.43 ± 2.44	2.2952*
Calcium (mg)	250.32 ± 112.22	347.75 ± 101.04	2.7534*
Vitamin A (µg)	1009.68 ± 368.27	2699.75 ± 2673.34	2.9420*
Thiamine (mg)	0.79 ± 1.46	0.59 ± 0.22	0.5580 NS
Riboflavin (mg)	0.64 ± 0.34	1.15 ± 0.98	2.2522*
Niacin (mg)	7.05 ± 4.03	8.14 ± 5.77	0.6846 NS
Vitamin C (mg)	15.42 ± 9.05	28.05 ± 32.51	1.7399 NS

NS = not significant
**Significant at 0.05 level*

nificantly higher than their counterparts (t = 2.121, 2.295, 2.753, 2.942 and 2.252, respectively) (Table 8).

To test the collective effect of predietary and postdietary elements on wound healing for the controls, multiple regression analysis was applied in Tables 9 and 10. Score of healing was taken as the dependent variable and the independent variables affecting it were dietary elements.

Table 9 shows that no statistically significant relations (positive or negative) were detected between any of the dietary variables or the score of healing, since all r-values were less than 0.413. Multiple regression was 0.67276 and R^2 = 0.45260. This means that these variables can explain 45.3% of the variation in the score of healing. F-value was 0.75166, which was not significant ($P > 0.05$). All t-values were insignificant.

Similar findings are displayed in Table 10; multiple regression was 0.69025 and R^2 = 0.47645. This means that 47.5% of these dietary variables were included in this multiple regression.

No relations were expected to exist between the experimental group subjects' dietary intake and wound healing, since healing scores were all zero.

Discussion

It is evident from the study that, in spite of the absence of significant differences among subjects of the two groups in blood picture and anthropometric measurements, the experimental subjects had significantly better scores of healing than the controls. Factors contributing to these outcomes merit discussion.

Table 9 **Correlation and multiple regression analysis of the control group preoperative average dietary intake and incisional wound healing**

Variable	Correlation coefficient, *r*	Regression coefficient, *b*	*t*-value
Caloric intake	–0.140	–2.4925	–1.105
Protein	–0.147	–5.3005	–0.670
Fat	0.262	1.0629	1.385
Carbohydrate	0.038	1.5635	0.096
Iron	0.005	–0.1159	0.667
Calcium	0.184	1.5009	0.161
Vitamin A	–0.229	–3.2411	–1.155
Thiamine	–0.217	–0.2159	–0.645
Riboflavin	0.343	0.0399	1.659
Niacin	–0.021	–5.1375	–0.719
Vitamin C	–0.090	3.2043	0.784

Multiple regression = 0.67276
R^2 = *Coefficient of determination = 0.45260*
F = *0.75166 (NS)*, P > *0.05*
Mean and standard deviation score of healing = 0.131 ± 0.195

Table 10 **Correlation and multiple regression analysis of the control group postoperative average dietary intake and incisional wound healing**

Variable	Correlation coefficient, *r*	Regression coefficient, *b*	*t*-value
Caloric intake	0.124	8.1412	0.042
Protein	–0.101	–0.1692	–1.868
Fat	0.152	0.0133	1.863
Carbohydrate	0.233	2.3559	0.883
Iron	0.112	3.5151	0.064
Calcium	0.008	–4.5114	–0.956
Vitamin A	0.226	–4.6174	–0.285
Thiamine	0.291	–2.3358	–0.061
Riboflavin	0.271	0.8253	1.885
Niacin	–0.87	0.0156	0.878
Vitamin C	0.073	–0.1168	–1.440

Multiple regression = 0.69025
R^2 = *Coefficient of determination = 0.47645*
F = *0.82731 (NS)*, P > *0.05*
Mean and standard deviation score of healing = 0.131 ± 0.195

The amounts of some dietary elements of food taken by the experimental group subjects were significantly better than those taken by their controls, both preoperatively and postoperatively. These included such elements as calcium, vitamin A, proteins, iron and riboflavin. For both groups, however, although some of these elements were within the acceptable percentages of the recommended daily allowances (RDA) for adults [*14*], others such as calories, proteins and vitamin C were still deficient (Tables 7 and 8).

Deficiency of such food elements may interfere with wound healing. Carbohydrates provide energy to wound cells, which helps in cell proliferation and phagocytic activity. Proteins aid in revascularization, lymphocytic formation and collagen synthesis. Vitamin C is required for the formation of collagen precursors and collagen. Vitamin A deficiency may also impede wound healing, since it is necessary for normal epithelization. The B-vitamins (thiamine, riboflavin and niacin) provide essential co-enzyme factors to metabolize carbohydrates and proteins. It appears that during wound healing thiamine deficiency, in particular, impairs collagen synthesis and decreases the breaking strength of the wound [*6*].

Cross-analysis of findings related to controls disclosed a relation between wound healing and nutritional status. This confirms the view expressed by Mullen, who revealed significant differences in complications, morbidity and mortality rates between two groups of malnourished and well nourished surgical patients [2].

Also the mean total hospital stay of the controls was found to be significantly longer. This may have adversely affected the morale of these patients, appetite and, subsequently, food intake. This agrees with the study made by Hafez et al., who found that lack of variations in the types of food served and the way it is cooked in the main University Hospital was a factor hindering food intake among burn patients [*15*,*16*]. Carvogal et al. add that nourishment requires regular variation in case of long term hospitalization [*17*].

As expected in the present study, individualized predictary and postdietary plans of the experimental group contributed to enhanced wound healing, decreased dehiscence and infection rates, and shorter hospital stay. This is in line with the views of Williams et al. who reported lower infection rates among surgical patients due to adequate preparation of predietary intake [*18*]. It is also in keeping with Windsor et al. who demonstrated that patients' recent food intake is more significant in determining wound-healing response than their overall nutritional status [*19*].

Yet, some wounds do not heal, or heal slowly even with proper nutritional care [*5*]. Elshazly et al. have reported poor wound-healing incidence of 8.8% after herniorrhaphy [*20*]. Davidson et al. and Hulton et al. have also attributed postoperative infections to the low resistance of old age, longer operative duration and incision [*21*,*22*]. Aseptic wound practices have dramatically decreased the incidence of postoperative wound infection. However, this condition still accounts for one-quarter of all nosocomial infections, which have a significant effect on the hospital morbidity and mortality rates in Egypt [*20*]. All these factors could perhaps additionally account for the poor wound healing (45.5%, Table 4) observed among the controls.

In the present study, it was evident that a significant number of subjects in the experimental group (56.2%) were better educated. This might have contributed (among other causes) to better dietary compliance. Naturally, better education influences individual earning power and food choice as well. Hence, the influence of culture on lifestyles cannot be ignored [*23*,*24*].

Conclusions

Good nutritional status is an asset for patients who are to undergo surgery. This study was carried out at the general surgical wards at Alexandria main University Hospital. The results display significant differences in wound healing due to dietary plans and interventions and emphasize the importance of nutritional surveys and counselling as well as recent preoperative and postoperative dietary intake.

Recommendations

- Nutritional assessment and surveys should serve as scientific bases for the preoperative planning of the nutrition and care of the surgical patient.
- Recent preoperative and postoperative dietary intake should be emphasized, since it might be more important than a patient's nutritional status.
- Nurses should actively participate in the assessment of dietary and biochemical laboratory indices and provide nutritional counselling accordingly to enhance would healing.

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