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ORIGINAL STUDY

Assessment of malnutrition in hip fracture patients : Effects on surgical delay, hospital stay and mortality

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The importance of malnutrition in elderly hip fracture patients has long been recognised. All patients operated upon for a hip fracture over a five-year period were assessed according to two nutritional markers : a) serum albumin levels and b) peripheral blood total lymphocyte count. Patients were subdivided into groups according to the four possible combinations of these results. Outcomes according to four clinical outcome parameters were validated : a) waiting time to operation b) length of hospitalisation, c) in-hospital mortality, and d) one-year postoperative mortality. Significant differences were found between malnourished patients and those with normal laboratory values with regard to surgical delay and one year postoperative mortality. Malnourished patients were also more likely to be hospitalised longer than a month and to die during their hospital stay, but the difference was not significant.

The combination of serum albumin level and total lymphocyte count can be used as an independent prognostic factor in hip fracture patients.

Keywords : hip fracture ; malnutrition.

INTRODUCTION

The importance of malnutrition as a predictor of poor clinical outcome in elderly patients has long been recognised. In hip fracture patients in particular, protein-energy malnutrition has been studied not only as a causative factor for fracture (*2, 18*), but also as an outcome determinant (*12*). Conversely, improved nutrition is considered a possible protective factor against geriatric trauma in general (*13*).

The exact incidence of protein-energy malnutrition in hospitalised patients remains rather obscure, partly because different methods are being used for its assessment. According to several studies with various evaluation criteria the incidence of malnutrition in elderly patients with hip fractures varies dramatically from 9.0% to 88.6% (*7, 8, 12, 14-17, 19*).

There is a lack of a reliable, objective, fast and inexpensive test, which the clinician could routinely use as a screening tool to identify malnourished hip fracture patients. Recently, the use of readily available and relatively inexpensive laboratory tests such as albumin levels and total lymphocyte count has been proposed (*12*). It is not clear yet whether these two markers can be used alone in routine screening of malnutrition in patients with a hip fracture. Moreover, their significance as predictors of a poor clinical outcome remains to be established.

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The aim of the current study was to validate whether these variables have a positive correlation with widely accepted clinical outcome parameters such as surgical delay, length of hospitalisation, in-hospital mortality and one-year postoperative mortality in hip fracture patients.

MATERIALS AND METHODS

All patients admitted with a hip fracture over a five-year period were studied retrospectively. Patients younger than 65 years of age and those not operated on, for any reason, were excluded from the study. For the remaining patients, serum albumin levels and total lymphocyte count results were retrieved from the medical records and used as markers of nutritional status. All samples were taken at admission. No postoperative laboratory results were taken into consideration. Values of < 3.5 grams/decilitre of serum albumin and < 1500 cells/mm^3 total lymphocyte count were considered abnormal.

Patients who met the inclusion criteria were subdivided into four groups according to the four possible combinations of these two variables :

(i) Group A had a preoperative albumin ≥ 3.5 g/dl and a total lymphocyte count $\geq 1{,}500$ cells/mm^3,
(ii) Group B had a preoperative albumin ≥ 3.5 g/dl and a total lymphocyte count $< 1{,}500$ cells/mm^3,
(iii) Group C had a preoperative albumin < 3.5 g/dl and a total lymphocyte count $\geq 1{,}500$ cells/mm^3,
(iv) Group D had a preoperative albumin < 3.5 g/dl and a total lymphocyte count $< 1{,}500$ cells/mm^3.

Descriptive statistics for discrete variables were presented as frequencies with percents. Continuous variables were summarised using means with standard deviations or using medians with interquartile ranges whenever more appropriate.

Outcomes were assessed according to four clinical parameters :

a) Waiting time to operation (< 2, or > 2 days)
b) Length of hospitalisation (≤ 30, or > 30 days),
c) Patients' in-hospital mortality,
d) Patients' one year postoperative mortality.

The effects of the four possible combinations of the two markers of nutritional status were examined to see if they were predictive of the outcomes described above, using multivariate logistic regression. These models were adjusted for the gender and the age of the patients. Statistical analyses were conducted in SPSS 11.0 (SPSS Inc, Chicago, IL, USA). All p-values were two-tailed. A p-value ≤ 0.05 was considered significant. No patients were examined or interviewed for the purpose of this study. The study was approved by the Trust's ethics committee. No financial support of this project occurred.

RESULTS

Between March 1st 1996 and March 31st 2001, 1627 patients were admitted to our hospital with a hip fracture. For 160 of these patients no operation was performed or recorded and they were excluded from the study. Another 60 patients were younger than 65 years and were also excluded. Of the remaining 1407 patients, 214 had a total lymphocyte count and albumin levels taken at admission, while 1193 had not. According to the results, these 214 patients were subdivided into four groups (table I).

The majority of the 214 patients were female (80%) and the mean age was 84 years. The median hospital length of stay was 19 days and the median waiting time to operation was 1 day. One in six patients (16.67%) died during their hospital stay, and one third of the patients (33.33%) died within 12 months of surgery.

From all the 1407 elderly patients (age > 65 years) operated for a hip fracture, a comparison was performed (table II) between the 214 patients included in the study (Group I) and those for whom both laboratory tests were either not taken at admission or their results were not available from the records (1193 patients, Group II). With regard to the patients' characteristics, the mean age and sex distribution between the two groups were comparable. Of the four clinical parameters studied, using the chi-square test, significant differences were found in the in-hospital mortality and the one-year postoperative mortality. On the other hand, patients' median length of stay and waiting time to operation were comparable between the two groups, using the Mann-Whitney test.

For the 214 patients who met the inclusion criteria, outcomes according to each clinical parameter were as follows :

Table I. — Patients' characteristics

	N = 214
Sex (%)	
Female	171 (79.9%)
Male	43 (20.1%)
Mean age in years (SD)	84.0 (± 18.2)
Nutritional markers	
Group A (Alb ≥ 3.5 g/dl & TLC ≥ 1,500 cells/mm^3)	39 (18.2%)
Group B (Alb ≥ 3.5 g/dl & TLC < 1,500 cells/mm^3)	110 (51.9%)
Group C (Alb < 3.5 g/dl & TLC ≥ 1,500 cells/mm^3)	18 (8.4%)
Group D (Alb < 3.5 g/dl & TLC < 1,500 cells/mm^3)	47 (22.4%)
Median length of hospital stay in days (IQR)	19 (11-35)
Median waiting time to operation in days (IQR)	1 (1-2)
In-hospital mortality (%)	36 (16.8%)
One year postoperative mortality (%)	71 (33.2%)

SD : Standard deviation ; IQR : Interquartile range.
Alb : Serum albumin ; TLC : Total lymphocyte count.

Table II. — Comparison of elderly patients included in the study (Group I) and excluded from the study (Group II)

	GROUP I	*GROUP II*
	N = 214	N = 1193
Sex (%)		
Female	171 (79.9%)	978 (82.0%)
Male	43 (20.1%)	215 (18.0%)
Mean age in years (SD)	84.0 (± 18.2)	84.0 (± 7.7)
Median length of hospital stay in days (IQR)	19 (11-35)	18 (11-30)
Median waiting time to operation in days (IQR)	1 (1-2)	1 (1-2)
One year postoperative mortality (%)	71 (33.2%)	285 (23.9%) p = 0.005
In-hospital mortality (%)	36 (16.8%)	139 (11.7%) p = 0.035

SD : Standard deviation ; IQR : Interquartile range.

a) *Waiting time to operation* (table III)

Patients with both an albumin level < 3.5 grams/decilitre and a total lymphocyte count < 1,500 cells/mm^3 (Group D) were 3.97 times as likely to be operated after 2 days compared with patients with normal levels (Group A) of both parameters (p = 0.030), adjusting for the gender and the age of the patients.

b) *Hospital length of stay* (table IV)

The median length of stay of Group D patients was at least a week longer than any other group. Moreover, Group D patients were 2.78 times more likely to have a hospital length of stay over one month compared to patients (Group A) with normal levels of both parameters (p = 0.062), adjusting for the gender and the age of the patients.

Table III. — Prediction of waiting time for operation greater than 2 days (multivariate logistic regression)

Predictors	*Median waiting time (days)*	*OR*	*95% CI*	*p-value*
Group A (Alb ≥ 3.5 g/dl & TLC ≥ 1,500 cells/mm^3)	1	1	–	–
Group B (Alb ≥ 3.5 g/dl & TLC < 1,500 cells/mm^3)	1	2.08	0.66-6.61	0.213
Group C (Alb < 3.5 g/dl & TLC ≥ 1,500 cells/mm^3)	1	1.18	0.19-7.21	0.855
Group D (Alb < 3.5 g/dl & TLC < 1,500 cells/mm^3)	2	3.97	1.15-13.72	0.030
Age (per 1-year increase)		0.97	0.92-1.02	0.214

OR : Odds ratio ; 95%CI : 95% confidence interval.
Alb : Serum albumin ; TLC : Total lymphocyte count.

Table IV. — Prediction of length of hospital stay greater than 1 month (multivariate logistic regression)

Predictors	*Median length of stay (days)*	*OR*	*95% CI*	*p-value*
Group A (Alb ≥ 3.5 g/dl & TLC ≥ 1,500 cells/mm^3)	18	1	–	–
Group B (Alb ≥ 3.5 g/dl & TLC < 1,500 cells/mm^3)	18	1.83	0.69-4.86	0.226
Group C (Alb < 3.5 g/dl & TLC ≥ 1,500 cells/mm^3)	19	1.40	0.34-5.84	0.643
Group D (Alb < 3.5 g/dl & TLC < 1,500 cells/mm^3)	26	2.78	0.95-8.16	0.062
Age (per 1-year increase)		1.04	0.99-1.09	0.120

OR : Odds ratio ; 95%CI : 95% confidence interval.
Alb : Serum albumin ; TLC : Total lymphocyte count.

c) *In-hospital mortality* (table V)

Group D patients were 2.22 times more likely to die during their hospital stay compared to patients (Group A) with normal levels of both parameters (p = 0.223), adjusting for the gender and the age of the patients. Interestingly, Group C patients (albumin level < 3.5 grams/decilitre and a total lymphocyte count ≥ 1,500 cells/mm^3) were 3.86 times more likely to die during their hospital stay than Group A patients (p = 0.072).

d) *One year postoperative mortality* (table VI)

According to the chi-square test, Group D patients were 3.02 times more likely to die within 12 months after surgery than patients (Group A) with normal levels of both parameters (p = 0.031), adjusting for the gender and the age of the patients. Also, Group C patients were 5.59 times more likely to die within 12 months after surgery than Group A (p = 0.008).

Table V. — Prediction of in-hospital mortality (multivariate logistic regression)

Predictors	*In-hospital mortality (%)*	*OR*	*95% CI*	*p-value*
Group A (Alb ≥ 3.5 g/dl & TLC ≥ 1,500 cells/mm^3)	10.3%	1	–	–
Group B (Alb ≥ 3.5 g/dl & TLC < 1,500 cells/mm^3)	13.5%	1.22	0.37-4.06	0.743
Group C (Alb < 3.5 g/dl & TLC ≥ 1,500 cells/mm^3)	33.3%	3.86	0.89-16.81	0.072
Group D (Alb < 3.5 g/dl & TLC < 1,500 cells/mm^3)	23.9%	2.22	0.62-7.96	0.223
Age (per 1-year increase)		1.05	0.99-1.11	0.082

OR : Odds ratio ; 95%CI : 95% confidence interval.
Alb : Serum albumin ; TLC : Total lymphocyte count.

Table VI. — Prediction of 1-year postoperative mortality (multivariate logistic regression)

Predictors	*One year postop. mortality (%)*	*OR*	*95% CI*	*p-value*
Group A (Alb ≥ 3.5 g/dl & TLC ≥ 1,500 cells/mm^3)	20.5%	1	-	-
Group B (Alb ≥ 3.5 g/dl & TLC < 1,500 cells/mm^3)	26.1%	1.16	0.46-2.90	0.753
Group C (Alb < 3.5 g/dl & TLC ≥ 1,500 cells/mm^3)	61.1%	5.59	1.57-19.97	0.008
Group D (Alb < 3.5 g/dl & TLC < 1,500 cells/mm^3)	50%	3.02	1.11-8.27	0.031
Age (per 1-year increase)		1.07	1.02-1.12	0.004

OR : Odds ratio ; 95% CI : 95% confidence interval.
Alb : Serum albumin ; TLC : Total lymphocyte count.

DISCUSSION

The optimal method for a practical approach to the complex concept of protein depletion in hip fracture patients remains to be agreed among clinicians. The current study is an effort to address the issue by using two simple laboratory tests, i.e. serum albumin levels and the peripheral blood total lymphocyte count. Based on the results, their relevance to widely accepted clinical outcome parameters is considered valid.

A weakness of the current study is that a relatively small percentage of patients operated for a hip fracture had both albumin levels and total lymphocyte count taken at admission. From the 1407 elderly patients, only for 214 (20.1%) were these results available. This was true especially for albumin, as lymphocytes are included in the usual full blood count taken at admission. Due to this small percentage there was a concern whether the patients studied were representative for the whole group. Using the rest of the patients (Group II, 1193 patients) as a control group, the two groups were comparable with regard to the patients' characteristics, the mean age and sex distribution. However, significant differences were found with regard to the one year postoperative mortality ($p = 0.005$) and in-hospital mortality ($p = 0.035$).

Since no prospective protocol was designed for the study, one would expect that patients who were submitted to an additional laboratory test (albumin) probably were those for whom there was a clinical suspicion of protein depletion or a history of other relevant co-morbidities. Therefore, it may not be surprising that the patients for whom both results were available had a poorer outcome according to two of the four parameters studied.

The incidence of malnutrition among elderly hospitalised patients remains an area of controversy. This is partly because of the fact that different authors are using various diagnostic criteria. In one study, when seven different published systems were applied on the same group of geriatric patients, an impressive variation of malnutrition from 6.5% to 85% was found (*9*). In any case, irrespective of the evaluation system used, the high incidence of malnutrition in elderly individuals with hip fractures has been well documented (*7, 8, 12, 14-17, 19*). In our study, the combination of serum albumin and total lymphocyte count as nutritional markers revealed a 22.4% incidence of malnutrition in elderly hip fracture patients (table I).

Among a plethora of biochemical markers available, serum albumin remains the protein of choice in assessing protein depletion (*10*). A level of 3.5 g/dl or higher is widely accepted as normal. In fact, some authors have used albumin levels alone as a laboratory indicator for malnutrition in orthopaedic patients (*3, 6*). However, no single nutritional index is considered reliable in identifying malnutrition in the elderly. It has been demonstrated that the discriminatory value of any single variable is relatively weak (*4*). Based on this principle, patients with only one of the two indices available were excluded from the current study.

Acute illness or injury can cause a rapid decrease in certain biochemical markers such as serum albumin. Therefore the use of albumin as a nutritional marker cannot be justified if measured postoperatively or days after admission (*1*). According to this, no such results were included in this study.

The combination of albumin levels with total lymphocyte count has the advantage of adding an immunological factor to the assessment. Moreover, total lymphocyte count has recently been re-validated as a nutritional marker in hip fracture women with a positive correlation to a low BMD in these patients (*5*). Therefore, this combination may be more useful as a screening tool than albumin alone for detecting malnourished patients.

In a previous study, Koval *et al* (*12*) studied the effects of malnutrition on a hip fracture population from an ongoing database. Four hundred and ninety patients were included in their assessment. To the best of our knowledge, this was the only published study where the same two laboratory tests (albumin level and total lymphocyte count) were used alone as indices for protein depletion in hip fracture patients. With regard to length of hospital stay, they found low albumin and total lymphocyte count levels to be predictive ($p = 0.03$) of a longer hospitalisation, using duration of two weeks as a threshold. In our series, the same group of patients was 2.78 times ($p = 0.062$) more likely to have a hospitalisation of more than a month as compared to Group A. Low albumin levels alone were also found to be predictive ($p = 0.03$) for an increased in-hospital mortality in Koval's study. In our series too there is a similar trend. Finally, with regard to one-year postoperative mortality they found patients with both indices below normal levels to be 3.5 times more likely to die within one year ($p = 0.02$). Similarly, Group D patients in our study were 3.02 times more likely to die within one year ($p = 0.031$).

In summary, our results reinforce Koval's findings with an additional strength : their database was confined to previously home-dwelling, ambulatory and cognitively intact elderly hip fracture patients. All these three factors have been correlated to a better outcome as shown in several previous studies (*11*). No such exclusion criteria were used in our cohort. In our assessment patients with poor pre-fracture ambulatory status, dementia and those living in nursing homes were included. Yet, even with all these categories included, malnourished patients still had a significantly poorer outcome. This suggests that albumin level and total lymphocyte count may represent a prognostic factor *per se.*

An interesting finding in our study is that Group C patients (albumin level < 3.5 mg/dl and

total lymphocyte count > 1500 cells/mm^3) had the worst outcome of all groups. Indeed, both in-hospital and one year postoperative mortality was higher in this group, higher even than in Group D patients. This seems paradoxical, since for these patients only one of the two indices, i.e. albumin, was abnormal, whereas the total lymphocyte count was within normal limits. Moreover, Group C patients were operated earlier than those in Group D : their median waiting time to operation was one day versus two days in Group D patients. Since surgical delay alone is a well studied detrimental prognostic factor for one year postoperative mortality in hip fracture patients (*13, 20*), this difference becomes even more important. It would be tempting to assume that the combination of low serum albumin levels with a normal total lymphocyte count represents a worse overall predictor. In any case, further study is needed to validate whether this remark is of any clinical significance.

It has to be emphasised that nutritional depletion in the elderly remains a rather complex and as yet not fully understood concept. Our aim was not to define malnutrition based on two parameters alone. Regardless how appealing, such a simplistic approach probably is erroneous. Rather, the objective was to use these two tests as a screening tool for the early detection and proper treatment of high risk patients.

CONCLUSION

Malnutrition in elderly patients with a hip fracture, as defined by low serum albumin levels and an abnormal total lymphocyte count alone, is related to a poorer clinical outcome. In our study, significant differences were found with regard to surgical delay and increased one-year postoperative mortality. Both laboratory tests are objective, relatively inexpensive, easy to perform, reliable and readily available. Our findings support the hypothesis that these nutritional markers can be used as independent prognostic factors in hip fracture patients. Their routine performance in clinical practice would facilitate the early detection of high risk patients.

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