

ORIGINAL PAPER

THE INFLUENCE OF PREOPERATIVE CARDIOVASCULAR ASSESSMENT AND TIME TO SURGERY ON POSTOPERATIVE MORTALITY AFTER SURGERY FOR FEMORAL NECK FRACTURES IN ELDERLY PATIENTS

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ABSTRACT

Introduction. A better predictive tool to use for assessing the risk of cardiovascular complications and postoperative mortality in elderly with femoral neck fracture is still not fully developed, and new data in stratifying the cardiovascular risk are still necessary.

The objective of the study was to determine the influence of preoperative variables from the cardiovascular preoperative assessment on mortality, and to try to set some standards in the preoperative management of patients with cardiac risk and hip fractures who need surgery.

Material and methods. We analyzed age, metabolic equivalents according (METS) to Duke Activity Status Index (DASI), hemoglobin, N-terminal prohormone of brain natriuretic peptide (NT-proBNP) and high sensitive C-reactive protein values, echographic measurements such as left ventricular ejection fraction (LVEF), left ventricular diastolic volume (LVDV) and diameter

RÉSUMÉ

L'influence de l'évaluation cardiovasculaire préopératoire et du délai opératoire sur la mortalité après la chirurgie pour les fractures du col fémoral chez les patients âgés

Introduction: Un meilleur outil prédictif à utiliser pour l'évaluation du risque de complications cardiovasculaires dans la mortalité des personnes âgées et la fracture du col du fémur en post-opératoire n'est pas encore complètement développé, et de nouvelles données pour stratifier le risque cardiovasculaire sont encore nécessaires.

L'objectif de l'étude était de déterminer l'influence des variables pré-opératoires à partir de l'évaluation pré-opératoire cardiovasculaire sur la mortalité et de définir des normes pour la gestion pré-opératoire des patients à risque cardiaque présentant une fracture de la hanche nécessitant une intervention chirurgicale.

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(LVDD), left ventricular wall hypertrophy (LVH) calculated as a mean of the posterior wall and the interventricular septum, the left ventricular contraction velocity S, pulmonary artery pressure (PAPs), the tricuspid annular plane systolic excursion (TAPSE), and time to surgery, for 72 patients aged over 60 y.o, hospitalised in the Orthopaedics Department of the University Emergency Hospital of Bucharest, Romania, between 2015-2016.

Results. The deaths after 3 months from surgery were 13 (18%). The best correlation with 3 month mortality was the delay in surgery over 4 days ($p < 0,0001$), with an area under the ROC curve of 0.943 and NT-proBNP values over 731 pg/L ($p < 0,0001$) and an area under the ROC curve of 0.898. Good correlations were found for an echocardiographic value of $s < 7,7$, with an area under the curve of 0.745 and a TAPSE $< 19,5$, corresponding to a area under the curve of 0.807.

Conclusions. The mortality was relatively high, and in our opinion, the gold standard should be speeding up the cardiovascular investigations and compensation of cardiovascular pathology, to allow surgery as early as possible, for a better survival of patients with femoral neck fractures.

Keywords: hip fracture, cardiovascular risk, time to surgery.

Matériel et méthodes: Nous avons analysé l'âge, les équivalents métaboliques (METS) selon l'indice DASI, l'hémoglobine, la prohormone N-terminale du peptide natriurétique cérébral (NTproBNP) et les valeurs de la protéine réactive C hautement sensible, ainsi que des mesures échographiques telles que la fraction d'éjection ventriculaire gauche (LVEF), le volume diastolique ventriculaire gauche (LVDV) et le diamètre (LVDD), l'hypertrophie de la paroi ventriculaire gauche (LVH), calculés en tant que moyenne de la paroi postérieure et du septum interventriculaire, la vitesse de contraction ventriculaire gauche S, la pression artérielle pulmonaire (PAP), le circuit systolique dans le plan tricuspide (TAPSE) et le délai d'intervention chirurgical pour 72 patients de plus de 60 ans hospitalisés au service d'orthopédie de l'hôpital universitaire d'urgence de Bucarest (UEHB) entre 2015-2016.

Résultats: Les décès après 3 mois de chirurgie étaient de 13 (18%). La meilleure corrélation à trois mois était avec le retard de l'intervention chirurgicale de plus de 4 jours ($p < 0,0001$) avec l'aire située sous la courbe ROC de 0,943 et NT-proBNP de plus de 731 g/l ($p < 0,0001$) avec une aire sous la courbe ROC de 0,898. De bonnes corrélations ont été trouvées pour une valeur échocardiographique $s < 7,7$ avec une aire sous la courbe de 0,745 et une TAPSE $< 19,5$ correspondant à une aire sous la courbe de 0,807.

Conclusion: La mortalité était relativement élevée et, à notre avis, tout doit être mis en œuvre pour accélérer les investigations cardiovasculaires et compenser la pathologie cardiovasculaire afin de permettre une chirurgie le plus tôt possible pour une meilleure survie des patients présentant une fracture du col du fémur.

Mots-clés: fracture de la hanche, le risque cardiovasculaire, le temps de la chirurgie.

INTRODUCTION

Femoral neck fractures in the elderly are a growing health problem, partly because of the increasing number of cases and, on the other hand, because of the aging of the population, by increasing the average age of these patients. Cases of hip fractures are often technically challenging when choosing the type of surgery, but especially by the way of multidisciplinary approach to associated pathologies. Current guidelines indicate surgical intervention only in life-threatening cases, and recommend that surgical intervention be performed as soon as possible even in patients with life-threatening neoplasms¹. Morbidity and mortality for patients with hip fractures in the period following surgery for elderly patients vary between 12% and 30%². Over 80% of patients with hip

fractures show significant comorbidities. Of these, the most common associated pathology is cardiovascular pathology (24%), followed by neurological disease, with a high proportion of cognition disorders and dementia³.

THE OBJECTIVE was to study if preoperative variables may help stratify the cardiovascular risk of death 3 months after femoral neck surgery in elderly patients. Considering that the number of femoral neck fracture patients in the University Emergency Hospital of Bucharest during 2015-2016 was more than 300 per year, and overall hip fractures exceeds 700 per year, these findings can improve preoperative tools that predict outcomes after hip surgery. There are also helpful data, that can be included in a stepwise protocol for preoperative management of this kind of

pathology, and also in the creation of a Hip Fracture Registry in our hospital and maybe at national level.

MATERIAL AND METHODS

The hypothesis of the study was that the most important factor influencing postoperative mortality and postoperative cardiovascular morbidity in patients at risk, according to the RCRI risk index, is the time from admission to surgery, in conjunction with cardiovascular specific clinical and paraclinical data. This factor is independent of how well the pre-operative cardiovascular risk is stratified. No matter how well a predictive model is used to stratify the risk of death and accurate postoperative cardiovascular morbidity, the key element in the treatment of these patients is to urgently initiate surgery with hip arthroplasty or osteosynthesis^{4,6}.

In this study, we prospectively evaluated 72 patients, who had surgery for femoral neck fractures, who were hospitalized between 2015-2016 in the Orthopaedics Clinic of the University Emergency Hospital of Bucharest, Romania. The end-point was 3 months after surgery, when it was recorded whether the patient died or not. The minimum age of patients was 60 years. Exclusion criteria were trauma older than 48 hours, polytraumas, patients who refused surgery, patients treated functionally, patients unable to perform echocardiography because of the impossibility of positioning in lateral decubitus on the fractured hip side, those in whom, for various reasons, cardiovascular biological markers could not have been measured, those who died preoperatively or were transferred to another service and those who were lost to follow-up.

Cardiovascular risk assessment was performed according to the Revised Cardiac Risk Index (RCRI). The patients included in the study required at least one RCRI criterion⁷. An estimate of functional capacity was performed according to the index of the DUKE questionnaire, which was then transformed into metabolic equivalents⁸. Preoperative values of hemoglobin, NT-proBNP and C-reactive high sensitive protein were noted^{9,11}. It was noted whether patients had atrial fibrillation at the time of presentation and if they took oral anticoagulants or antiplatelet agents at home. The reason for introducing these variables was that these associations of pathology and medication often delay surgical intervention, increase perioperative bleeding, lower hemoglobin levels, and increase the need for blood transfusion. Preoperatively, in the cardiovascular assessment, the cardiologist performed a transthoracic echocardiography, with the evaluation of the ejection fraction, left ventricle end-systolic volume and diameter, left

ventricular systolic contraction rate, left ventricular hypertrophy, represented by mean interventricular septum thickness and posterior wall, pulmonary artery pressure, and tricuspid ring systolic (TAPSE) excursion. The time from admission to surgery was noted in units of days¹². Three months after surgery, following a telephone survey, one of the patient's first-degree family members was asked if the patient survived up to that date. Data were introduced and processed with the IBM SPSS Statistics Viewer version 25.

RESULTS

Of the 72 follow-up patients, 13 deaths were recorded at 3 months after surgery, which is 18.1%. Rehospitalisation for cardiovascular pathology was recorded for 17 patients, representing 23.6%. Of the 72 patients, 22 were men and 50 were women. The average age was of 77.18 ± 6.76 years. The mean functional capacity, expressed in metabolic equivalents according to the DUKE index, was 5.10 ± 0.72 . With regard to the distribution of patients according to preoperative cardiovascular risk criteria, using the Revised Cardiac Risk Index, patients with one risk criterion were 65% ($n = 47$), with two risk criteria 27.8% ($n = 20$) and with three risk criteria 6.9% ($n = 5$) (Table 1).

The mean value of NT-proBNP was 755 pg/mL, with extreme values between 13 and 5254 pg/mL. The mean C-reactive high sensitive protein was 20.19 mg/L. 33% of patients ($n = 24$) had values above 30 mg/L, while values between 10 and 20 mg/L were recorded in 40.3% of patients ($n = 29$). Hemoglobin values on arrival at the orthopaedic ward ranged from a minimum of 8.9 g/L to 16 g/L, with a median of 12.9 g/L (standard deviation = 1.63) (Table 2).

The estimated left ventricular ejection fraction had an average of 54.3%, with a standard deviation of 0.9. The mean S-wave contraction rate of the left ventricle is 7.9, with a standard deviation of ± 0.11 . The mean left ventricular volume measured in the left ventricle is 103.17 mL and the left ventricular telediastolic diameter is 49.1 mm. The mean left ventricular wall (mean posterior wall size and interventricular septum) was 11.2 mm. The mean pulmonary artery pressure was 29.1 mm Hg and the mean tricuspid excursion was 21.3 mm (Table 3).

The time to surgery, from the time of admission, was an average of 4.16 days, with a minimum of 1 and a maximum of 11 days (standard deviation = 2.01). On the first day of admission, 4.2% of patients ($n = 3$) were operated; on the second day, 9 patients were operated (12.5%); on the 3rd day - 22.2% ($n = 16$) were operated. Cumulatively, 38.9% of patients were operated in the first 3 days of admission. Surgery

Table 1. Description of the preoperative assesment tools variables and deaths

Variable	Number/percent	
Gen	Masculin	22 (30.6%)
	Feminin	50 (69.4%)
Age	77.18 +/-0.88	
RCRI	1	47 (65.3%)
	2	20 (27.8%)
	3	5 (6.9%)
METS (DUKE)	5.1 +/-0.081	
Time to surgery	4.15 +/-2 zile	
Death	13 (18.1%)	

Table 3. Description of the echocardiographic parameters

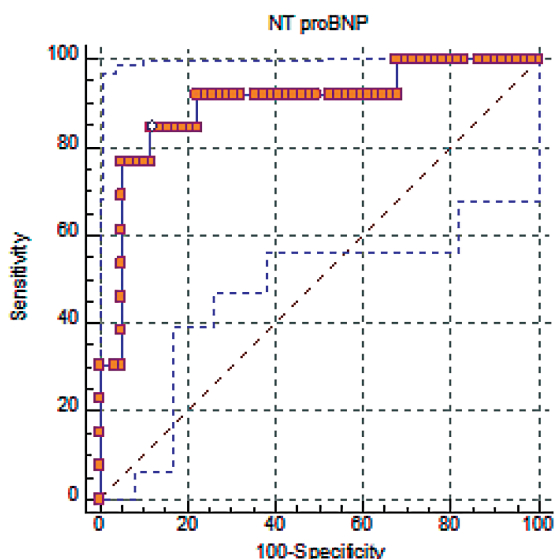
Echographic parameters	Mean +/- std. dev. (min-max)
LVEF	54.3+/-0.9 (40-65)
S velocity of contraction LV	7.9+/-0.11 (6-9.6)
TD volume of LV (LVDV)	103.17+/-2.1 (80-155)
TD diameter of LV (LVDD)	49.1+/-0.56 (40-59)
LVH	11.2+/-0.15 (9-14)
TAPSE	21.3+/-0.26 (17-28)
PAPs	29.1+/-1 (15-60)

took place on the 4th day for 33.3% of patients (n = 24), while between days 5 and 11, 27.9% of all patients were operated. As a result, 61% of the patients were operated after 4 days of hospitalization in the orthopaedics department. It was observed that the RCRI distribution was predominant in the death group. The RCRI score is higher in the death group

Table 2. Description of the serological variables

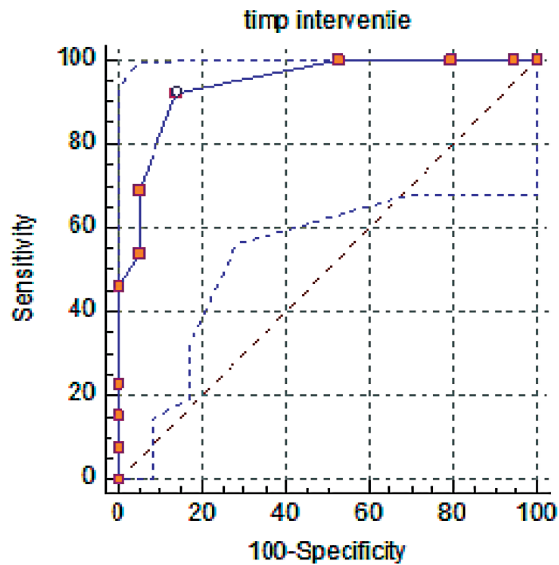
Serologic variables	Mean +/- std. dev. (min-max)	
NT-proBNP	755.9+/-122.9 (13-5234)	
Hb	>14	20 (27.8%)
	11-14	44 (61%)
	<11	8 (11.1%)
High Sensitivity CRP	20+/-1.1 m/s (2-30)	
	0-10	11 (15.3%)
	10-20	29 (40.3%)
	20-30	8 (11.1%)
	>30	24 (30.3%)

compared to the live group, with statistically significant difference (p <0.0001). Also, the presence of anticoagulants in chronic treatment was associated with death from anti-aggregation, which was predominant in the group of survivors (p <0.029). Based on bivariate analysis of the parameters, correlation with death at 3 months after surgery was the most potent time to surgery (p <0.0001) and elevated NT-proBNP (p <0.0001). Other parameters that correlated with 3-month death were the value of left ventricular contraction S and TAPSE with p = 0.0028 and the area ROC 0.745 and respectively p = 0.0002 and the area under the ROC 0.807 curve. An increase in time from admission to surgery over 4 days increased the risk of death by 4.8 times. The ROC curve analysis for the time variable from admission to surgery shows an area under the 0.943 curve vs. 0.898 for the time to surgery and NT-proBNP variable. In the case of the analysis of the increased value of NT-pro BNP for a value above 731 pg/L, the risk of death was twice as



Area under the ROC curve (AUC)	0.898
Standard Error ^a	0.0531
95% Confidence interval ^b	0.804 to 0.957
z statistic	7.499
Significance level P (Area=0.5)	<0.0001

Figure 1. ROC curve for NTproBNP



Area under the ROC curve (AUC)	0.943
Standard Error ^a	0.0308
95% Confidence interval ^b	0.862 to 0.984
z statistic	14.392
Significance level P (Area=0.5)	<0.0001

Figure 2. ROC curve for time to surgery

high as the values below this limit, but the specificity was 88% and the specificity of 84%. (Figures 1, 2).

CONCLUSIONS

From the above results, we note that the 3-month mortality is increased when preoperative values of NT-proBNP are higher than 721 pg/L, the variable predicting the risk of heart failure, echocardiographic measurement values suggestive for systolic and diastolic dysfunction and increased time to surgery over 4 days. We found that, regardless of the reason, whether it is for medical evaluation and surgery clearance purposes, a stabilization of a decompensated medical condition or other technical aspects (operating room availability, consultation delay due to overcrowding, etc), the delay to surgery is too great in the population of patients that we have followed.

The conclusion we have reached is that shortening the time to surgery is an essential component to lower cardiovascular mortality and morbidity in the medium and short term in patients with cardiovascular risk factors that suffer from femoral neck fracture. From our point of view, it is imperative to thoroughly investigate the patients, to stratify the postoperative cardiovascular risk through echocardiography, serum biomarkers etc, but these should be done as soon as possible to immediately correct cardiovascular decompensations and allow clearance to surgery without undue delay. In our opinion, operative treatment is the only medical therapy able to provide a satisfactory functional recovery of elderly patients with femoral neck fractures, and the efforts of the entire medical team involved in the receipt, triage, preoperative assessment, peri-operative management, must converge to as early as possible clearance for surgery.

Compliance with Ethics Requirements:

„The authors declare no conflict of interest regarding this article“

„The authors declare that all the procedures and experiments of this study respect the ethical standards in the Helsinki Declaration of 1975, as revised in 2008(5), as well as the national law. Informed consent was obtained from all the patients included in the study“

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