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Hip fracture surgery: Is the pre-operative American Society of Anesthesiologists (ASA) score a predictor of functional outcome?

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ABSTRACT. ***Background and aims:*** *Many studies have identified specific demographic, social, health or life-style pre-operative indicators of long-term outcome among older hip fracture patients who underwent surgical treatment. The purpose of this study was to determine the predictive value of peri- and intra-operative factors, and more specifically of the pre-operative American Society of Anesthesiologists (ASA) score on functional outcome in these patients.* ***Methods:*** *A questionnaire designed to assess pre-fracture functional and health status was administered to surgically treated hip fracture patients. Post-fracture functional and health status was further ascertained by in-home interview one year after the operation. Among 140 consecutive eligible patients older than 65 years, 10 either refused subsequent interviews or could not be contacted; an additional 16 patients died during the year of follow-up, leaving 114 patients available for this study.* ***Results:*** *The average age of the patients was 82.4 years. Almost two-thirds of them suffered from severe systemic disease, whether or not incapacitating (ASA grades III-IV). Subjects classified in these categories presented more frequently with cardiovascular disorders, were more frequently disoriented, and already had some pre-fracture difficulty with ambulation. The mortality at one year was almost nine times higher in severely impaired patients (grades III-IV) than in healthy or mildly affected patients (grades I-II). Functional outcome and/or ambulatory ability assessed at one year did not reveal any statistically significant difference between the ASA I-II and III-IV groups. The most pronounced difference was noticed for the functional independence measured by the ADL score (p=0.236). Better prognoses were consistently recorded for patients with an intracapsular fracture, for those who were operated within 24 hours, for those treated with a prosthesis as opposed to internal fixation, and for those whose operating time was less than 1 1/2 hours.* ***Conclusions:*** *Although the ASA classification is a good predictor of long-term mortality, the findings of the present investigation do not conclusively associate ASA score with post-operative restoration of mobility and functional independence.*
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INTRODUCTION

A fracture of the proximal femur (hip fracture) represents perhaps the most dramatic consequence of osteoporosis in terms of disability, mortality, long-term institutional care and cost (1). Although the majority of the patients undergo surgical treatment, the proportion of those not completely recuperating to their previous levels of independence remains high. Many studies have identified specific pre-operative indicators of long-term outcome based on background demographic, social, and health variables, as well as living conditions and functional varlables such as pre-morbid state and activities of daily living (2-10).

The objective of this study was to determine the predictive value of peri- and intra-operative factors, and more specifically of the pre-operative American Society of Anesthesiologists (ASA) score (11) on functional outcome among older hip fracture patients.

METHODS

Patients

This prospective longitudinal study evaluated 140 consecutive patients older than 65 years presenting with a proximal femoral fracture and admitted to the Division of Orthopedic Surgery of the University Hospital of Geneva,

Key words: ASA score, elderly, functional outcome, hip fracture surgery, rehabilitation prognosis.

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Switzerland. Exclusion criteria were severe dementia, near-terminal diseases, or total absence of rehabilitative potential; patients with severe dementia were unable to be interviewed and patients who were non-ambulatory prior to surgery were not considered to have any potential for rehabilitation following the surgical intervention. Patients treated non-operatively were also excluded.

Within one week of hospital admission, the patients were administered a questionnaire designed to assess pre-fracture functional and health status. A proxy respondent was interviewed when patients were unable to provide information because of cognitive limitations. Post-fracture functional and health status was further ascertained by in-home interview at three months and one year after the fracture. Five subjects refused the second or third interview, and contact was lost with 5 other subjects. Furthermore, 16 patients died during the year of follow-up, so that this study is based on information regarding 114 patients.

Independent variables

Demographic data included gender, age, and place of residence. Pre-fracture evaluation of daily living activities (ADL) was based on answers to the first interview. Each of the six activities retained (bathing, dressing, grooming, walking, eating, and toileting) was rated on a 3-point scale (1=without any difficulty, 2=with some difficulty, 3=complete inability), and the ADL score was defined as the sum of the 6 item codes. Information on diagnosed cardiovascular diseases, diabetes or disorientation was retrieved from the hospital medical file. The number of medications prescribed, and the number of medical consultations in the last three months were also recorded. The hip fractures were classified into intracapsular and extracapsular types. Intracapsular fractures included subcapital and transcervical fractures. The extracapsular fractures included basicervical, pertrochanteric, and subtrochanteric fractures. Peri- and intra-operative factors included timing of surgery, type of surgical procedure (osteosynthesis or arthroplasty), type of anesthesia (spinal or general), number of blood transfusions, number of hypotension spells, number of desaturation spells, need of vasopressor treatment, and the operative time. This last variable was used to qualify the surgical load (threshold value of $1^1/_2$ hours to distinguish heavy from normal load). All patients were classified according to the ASA score, a pre-operative 5-point grading scale proposed by the American Society of Anesthesiologists (11): I=healthy patient; II=patient with mild systemic disease; III=patient with severe systemic disease not incapacitating; IV=patient with incapacitating systemic disease; and V=moribund patient.

Dependent variables

Six variables were evaluated at three months after fracture, and again at one year to assess the functional results of our patient population. These included:

1. Survival.
2. Mobility status, self-reported by an answer to the question, "Can you walk or transfer as well as before having fractured your hip?"
3. Mode of transfer, rated on a 7-point scale (1=walks alone and uses stairs, 2=walks alone but does not use stairs, 3=needs one or two canes, 4=needs a walker, 5=needs a wheelchair, 6=is confined to chair, 7=is confined to bed).
4. Activities of daily living (ADL) including bathing, dressing, grooming, walking, eating, and toileting. Ability rated on a 3-point scale for each activity (1=without any difficulty, 2=with some difficulty, 3=complete inability). The ADL score, defined as the sum of the six item codes, ranges from 6 (total independence) to 18 (complete dependence).
5. The ADL item concerning walking ability, rated as indicated above.
6. Total number of hospital days during the year of follow-up, obtained by summing all lengths of hospital stay either for acute or chronic conditions, including convalescence and rehabilitation.

Statistical analysis

All the data collected were computerized and processed with the help of appropriate programs provided by the Statistical Package for the Social Sciences (SPSS) (12). Logarithm transformation was applied to the length of hospital stay in order to normalize the distribution.

In bivariate analyses, statistical significance was tested using (a) the χ^2 test or Fisher's exact probability test when both categorical variables were dichotomized, and (b) Student's *t*-test to assess the association between a dichotomized variable and a continuous variable. Relative risks of death during the first year of follow-up and their 95% confidence intervals were calculated for selected pre-operative health-related factors. All reported *p*-values are two-tailed, and the null hypothesis of no difference was rejected at a *p*-level of less than 0.05.

RESULTS

The average age of the patients was 82.4 years

Table 1 - *Mean age and ASA grading expressed as percent of patient total.*

	Mean age (SD)	82.4 (7.9)
	ASA grading	
I	Healthy patient	2.5%
II	Patient with mild systemic disease	34.2%
III	Patient with severe non-incapacitating systemic disease	56.6%
IV	Patient with incapacitating systemic disease	6.7%
V	Moribund patient	0.0%

Table 2 - *Pre-operative health-related factors associated with the ASA classification*[a].

Pre-operative health-related factors	Overall prevalence (%)	Prevalence in patients with ASA grades I-II (%)	Prevalence in patients with ASA grades III-IV (%)	*p*
Heart failure	46.7	20.5	61.8	0.000
Arrhythmia	44.2	27.3	53.9	0.005
Other CV pathologies	35.8	15.9	47.4	0.001
Diabetes	15.0	9.1	18.4	0.168
Intracapsular fracture	41.7	29.5	48.7	0.040
Difficulty in walking	29.2	18.2	35.5	0.044
Disorientation	11.7	0.0	18.4	0.002
Medical consultations[b]	47.5	29.5	57.9	0.003
Drug treatment[c]	78.3	61.4	88.2	0.001

[a)] Physical status classification of the American Society of Anesthesiologists. [b)] Two or more medical consultations in the last three months. [c)] Two or more drugs prescribed.

(SD=7.9 years), and 85% were female. The percentage distribution of ASA scores is shown in Table 1. Less than 3% of the patients were classified as healthy by the anesthesiologists, and almost two-thirds of them suffered from severe systemic disease, incapacitating or not. On average, patients with ASA scores of III or IV were slightly, but not significantly older (82.7±7.5 years) than those with scores of I or II (80.9±8.9 years). Pre-operative health-related factors that may have played a determinant role in the patients' ASA classification are listed in Table 2. As expected, the prevalence of cardiovascular pathologies was significantly higher in patients with ASA scores of III and IV; these patients were also more frequently disoriented, greater consumers of medical services, already had some pre-fracture difficulty with ambulation, and were more prone to an intracapsular fracture. The poor prognostic value of some of these ASA-associated pre-operative factors is confirmed in Table 3. The overall death rate during the course of the first post-discharge year was 13.2%. The risk of death during the first year of follow-up was almost six times higher in the presence of arrhythmia, and practically three times higher in case of heart failure or of more frequent visits for medical treatment. The most significant contrast in survival was observed for the ASA classification. Mortality at one year was almost nine times higher in severely impaired patients (grades III-IV) than in healthy or mildly affected patients (grades I-II).

The association of ASA score with functional outcome at one year is shown in Table 4. Although unfavorable prevalences, including difficulty with ambulation prior to fracture, were always observed in the surviving patients who had been graded III or IV in the ASA scale, for no outcome did the difference between ASA I-II and III-IV groups reach statistical significance. The most pronounced difference was noticed for functional independence measured by the ADL score (p=0.236). Table 5 reports the prevalence of functional outcome in terms of recovered mobility and ability to walk without difficulty one year after surgical intervention according to various pre- and post-operative factors. Better results were recorded for intracapsular fracture, surgery within 24 hours, arthroplasty as the surgical procedure, and normal surgical load (operative time no more than $1^1/_2$ hours). However, the prognostic value of these findings remains uncertain, as the conventional level of statistical significance was not reached for any of these dichotomized factors.

DISCUSSION

Although the ASA scoring system is not intended to be a risk classification scheme, increased morbidity and mortality are correlated with physical status (13) for any age group, including the elderly (14). The present findings confirm that the ASA classification is a good pre-

Table 3 - *Risk of death during the first year of follow-up for selected pre-operative health-related factors.*

Pre-operative health-related factors	Relative risk (95% CI)	*p*
Heart failure	2.80 (1.05-7.50)	0.030
Arrhythmia	5.79 (1.75-19.20)	0.001
Other CV pathologies	0.96 (0.38-2.44)	0.937
Intracapsular fracture	0.93 (0.38-2.28)	0.865
Difficulty in walking	1.05 (0.40-2.77)	0.926
Disorientation	2.36 (0.88-6.30)	0.097
Medical consultations[a]	2.98 (1.11-7.97)	0.021
Drug treatment[b]	2.15 (0.52-8.88)	0.263

[a)] Two or more medical consultations in the last three months. [b)] Two or more medications prescribed.

Table 4 - *Prevalence of functional outcome at one year according to ASA classification.*

Outcomes	Prevalence in patients with ASA grades I-II	Prevalence in patients with ASA grades III-IV	*p*
Mobility self-reported as recovered (%)	51.2	45.9	0.597
Walking without difficulty (%)	39.5	34.4	0.594
Confined to weelchair or bed (%)	16.3	16.4	0.988
Mean ADL scores (SD)	9.9 (3.6)	10.8 (3.8)	0.236
Mean number of hospital days/year (SD)	65.1 (2.3)	65.3 (2.1)	0.983

dictor of long-term mortality (15-17), but its association with post-operative restoration of functional independence is not significantly demonstrated. By definition, ASA class determination by the anesthesiologist is based on the appreciation of pre-operative health-related factors, some of which are evaluated by the surgeon when deciding for a particular surgical procedure. As a consequence, multiple interdependencies between pre-operative, peri-operative, and intra-operative factors could be expected, and these relationships might also be reflected in the concurrence of their respective predictive value of post-operative outcomes.

Many studies of the factors potentially related to functional rehabilitation in hip fracture patients have shown how complex the recovery process is. Among others, factors predictive of poor post-operative ambulation and ADL functioning have been shown to be older age, longer hospital stays, re-hospitalization, chronic or acute cognitive deficits, depressive symptomatology while hospitalized (3), as well as pre-fracture physical function and cognitive impairment (9). Ochs (18) observed that the recovery of patients following hip fracture can often be predicted pre-operatively, and he cited risk factors for poor functional outcome such as pre-morbid dementia, poor mobility, intertrochanteric fracture, and advanced age. He pointed out that mobility

Table 5 - *Prevalence of functional outcome at one year according to peri- and intra-operative variables.*

Peri- and intra-operative factors	Mobility recovered[a] (%)	*p*	Walking without difficulty (%)	*p*
Type of fracture				
intracapsular	53.1	0.251	44.9	0.096
extracapsular	42.2		29.7	
Delay				
surgery within 24 hours	52.3	0.171	41.5	0.272
surgery beyond 24 hours	38.5		30.8	
Surgical procedure				
arthroplasty	53.1	0.251	44.9	0.096
osteosynthesis	42.2		29.7	
Type of anesthesia				
spinal	47.8	0.825	35.8	0.710
general	50.0		39.5	
Blood transfusion				
no	45.7	0.337	37.0	0.987
yes	57.9		36.8	
Spell(s) of hypotension				
no	39.2	0.090	39.2	0.696
yes	56.3		35.4	
Vasopressor treatment				
no	38.9	0.061	38.9	0.733
yes	57.8		35.6	
Surgical load[b]				
normal	48.4	0.495	37.6	0.519
heavy	40.0		30.0	

[a] Mobility self-reported as recovered.
[b] Normal: operative time no more than $1^1/_2$ hours; heavy: operative time more than $1^1/_2$ hours.

serves as a rough indicator of major organ system function, and while such patients usually have significant co-morbidities he did not relate outcome to the admission ASA score. Other investigators found that fracture type correlates poorly with functional outcome (19-21), and while a number of variables related to a better outcome were reported, none of the studies addressed the issue of pre-operative ASA score.

Koval et al. (22) reviewed 336 patients with a minimum one-year follow-up using multiple logistic regression analysis, and identified four factors that contributed significantly to ambulatory recovery; these included age, ASA score, pre-fracture ambulatory status and type of fracture. The "young-old" patient (less than 85 years of age) with an intracapsular fracture who was ambulatory prior to the injury, and with an ASA score of I-II, had a more favorable outcome. Palmer and Parker (23) reviewed 643 hip fracture patients with regard to their functional outcome. They only looked at the residential status of the patient at the time of follow-up, and defined a successful outcome as one in which the patient was alive and not living in a residential facility, nursing home, or hospital one year after injury. This included any patient at such a facility for any other reason (cognitive difficulties, other medical problems, etc.). They considered that pre-fracture mobility was the most significant predictor of functional outcome at one-year post-injury, but also noted other significant favorable factors such as a younger age, better mental status, intracapsular fracture, and an ASA score of I-II. In a review of 171 fractures, of which 133 were available at follow-up, Hamlet et al. (15) looked at post-operative mortality and functional outcome. The main focus of the study was mortality and its relation to the timing of surgery and ASA score. Their conclusion was that the ASA score itself was a good predictor of mortality, but patients who had surgery within 24 hours of admission had a significantly lower mortality rate than patients who underwent surgery more than 24 hours after admission, regardless of their pre-operative ASA score. They incidentally described a better functional outcome for patients with ASA scores of I-II, but only used the distance that the patient could walk as their outcome measurement.

In contrast to several previous studies (15, 22, 23), our results provide new information in that we did not find any conclusive association between the pre-operative ASA physical status classification of our patients and the outcomes assessed at one-year follow-up in terms of ambulation capacity, functional independence and duration of hospitalization. However, not all investigators use totally identical outcome measures. We also did not find any significant association between the other pre-operative and intra-operative variables and functional outcome at one year. This however, was not unexpected, as poorer ASA scores were clearly more strongly correlated with a poor survival. The absence of a statistically significant relationship between intra-operative factors and post-operative recovery of walking ability, as noticed in our study, is consistent with the findings of other investigators who reported that time of surgery was not a significant predictor of ability to ambulate after surgery (15), that patients receiving spinal or general anesthesia did not differ with respect to ambulation (16), and that the type of surgical procedure performed was not significantly associated with post-surgical functional recovery (8).

CONCLUSIONS

With an expected substantial increase in our elderly population, and a resultant increased number of hip fractures, rehabilitation and social service resources will be further strained in attempts to provide adequate care to all. The goal of studies addressing pre-fracture and peri-operative variables is to help identify those patients who can benefit most from an aggressive, post-surgical rehabilitation program. Yet, a comprehensive approach to risk prediction of post-operative outcome can only be multifactorial. Although of limited scope, the ASA scoring system is an instrument to assess the general health of the patient, and it has clearly been demonstrated to be a significant predictor of post-surgery survival. However, the ASA score by itself does not seem to be a valuable prognostic determinant of long-term mobility and functional independence recovery.

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