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The Timing of Surgery for Hip Fracture and its Effects on Outcomes

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Abstract

Context—Previous studies of surgical timing in patients with hip fracture have yielded conflicting findings on mortality and have not focused on functional outcomes.

Objectives— We examine the impact of surgical timing on function and other outcomes.

Design—Prospective cohort study. Additional analyses involved a) matching cases of early and late surgery with propensity scores, and b) analysis of a restricted cohort that excluded patients who might not be candidates for early surgery

Setting—Four hospitals in the New York metropolitan area.

Participants—1206 patients age ≥50 admitted with hip fracture over 29 months.

Intervention—Timing of surgery from hospital arrival.

Main Outcome Measures—Information collected from medical records and from interviews with patients or proxies during hospital stay. Follow-up information obtained on function (using the Functional Independence Measure) and survival.

Results— Of the patients treated with surgery (n=1178), 33.8% had surgery within 24 hours. Earlier surgery was not associated with improved mortality (hazard ratio = 0.75; 95% CI 0.52, 1.08) or improved locomotion (difference of −0.04 points, 95% CI −0.48, 0.39). Earlier surgery was associated with fewer days of severe pain (difference of −0.22 days, 95% CI −0.41, −0.03) and shorter length of stay by 1.94 days (p<0.001). Analyses with propensity scores or with a restricted cohort

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yielded similar results except that early surgery was also associated with reduced major complications in the restricted cohort (p=0.041).

Conclusions—Early surgery was not associated with improved function or mortality, but it was associated with reduced pain, length of stay and probably major complications. Additional research is needed on whether functional outcomes may be improved. In the meantime, patients with hip fracture with stable medical problems should be treated with early surgery given that adverse events are unlikely and that pain, length of stay, and possibly complications will be reduced.

The incidence of hip fracture is increasing in the United States, with more than 340,000 occurring in the year 2000 1. In the elderly, the one-year mortality for hip fracture ranges from 14–36% 2. Additionally, hip fracture is associated with poor functional outcomes3, 4.

Surgical repair is a key element in the management of hip fracture. Before surgery, most patients are confined to bed. In theory, delay in surgery and mobilization could affect functional and other outcomes by increasing bedrest-associated complications, including thromboembolism5, urinary tract infections 6, atelectasis, and pressure ulcers 7. On the other hand, precipitous surgery and failing to stabilize medical problems could increase the risk of perioperative complications.

Whether early surgery is beneficial is a long-running controversy and is one of the most common clinical issues in the early acute management of these patients. A randomized trial of surgical timing in hip fracture has never been conducted, but the impact of timing on outcomes has been examined in other studies 8–20. Many of these studies did not adjust for co-morbid illness or other parameters that might be used to "select" patients for earlier surgery. Of the studies that controlled for co-morbidity 11, 14, 16, 17, 19, some found that early surgery is associated with lower mortality, length of hospital stay, and complications. A recent and large study 20, however, found that surgery after 48 hours had no effect on mortality compared to surgery in 24–48 hours. Of note, virtually all studies evaluated the effect of early surgery primarily on mortality rather than functional outcomes. In this study, we examine the impact of the timing of hip fracture surgery on mortality and functional and other outcomes, including pain, length of stay and complications.

Methods

Consecutive admissions to four hospitals in the New York metropolitan area were screened for cases of hip fracture for 29 months ending December 1999. The hospitals included one academic medical center, an urban teaching hospital, an orthopedics hospital, and a suburban hospital. Exclusion criteria included patient age less than 50, fractures that occurred as an inpatient, transfers from another hospital, multiple trauma, pathologic fractures, distal and femoral shaft fractures, bilateral hip fractures, or previous fracture or surgery on the currently fractured site. Informed consent was obtained from subjects. Of the 1741 cases admitted, 23.4% met exclusionary criteria, 4.1% refused to participate, 2.6% were discharged before consent could be obtained, 0.6% had incomplete data, and 69.3% (n=1206) were enrolled.

Trained research associates enrolled patients as early in the admission as possible (69% were enrolled on or before the day of surgery). Information on pre-fracture function, residential location, and history of dementia was collected from patients or their proxies (if the patient was delirious or cognitively impaired). Information on each patient's functional status for the two weeks prior to fracture was obtained by interview using the motor scale of the Functional Independence Measure (FIM) 21 which consists of 13 items in 4 subscales of physical functioning (locomotion, self-care, toileting, and transferring). Each item was scored between 1 (for complete dependence) and 7 (for complete independence) using specific criteria. Medical

records were reviewed throughout the hospital admission to collect information on comorbid medical problems, type of fracture, and other aspects of medical care.

Information was also collected on abnormal clinical findings (admission physical examination and laboratory findings) that are commonly available and used by clinicians to decide whether or not to delay surgery. This information was used to determine whether the patient had a) a systolic blood pressure ≤90 mm Hg; b) a rate or rhythm abnormality (defined as atrial fibrillation or supraventricular tachycardia at a rate > 120 beats per minute, ventricular tachycardia, 3° block, or a rate ≤ 45 beats per minute); c) chest pain or myocardial infarction within 3 months; d) poorly compensated heart failure (a chest x-ray consistent with congestive heart failure, the presence of dyspnea, abnormal lung findings [e.g., rales, rhonchi, and decreased breath sounds] or an S3 gallop); e) an abnormal INR of ≥ 1.4; and f) a laboratory abnormality (sodium <125 or >155 mEq/L; potassium <2.5 or >6.1 mEq/L; bicarbonate <18 or >36 mEq/L; glucose>600 mg/dL; blood urea nitrogen >50 mg/L; creatinine >2.5 mg/dL; hemoglobin ≤ 7.5 g/dL; a pulse oximetry reading of <90%; a pO_2<60 mm Hg; or a pCO_2>55 mm Hg). Cut-off values were established by examining the relationship between the occurrence of early surgery and the range of values for each finding.

For the patients enrolled during the first 12 months, each patient was also seen five days a week in the hospital to collect additional information on pain and on complications. On each visit, the patient was asked to assess pain severity for the previous 24 or 48 hours (on a 5 point scale ranging from no pain to very severe pain). The hospital course and medical record were reviewed at each visit, and complications were recorded. Major complications were defined as those that posed a threat to life or bodily functions and that typically are treated with parenteral medications, procedures, or intensive monitoring. Examples of major complications include: 1) pneumonia if both respiratory symptoms and/or hypoxia were documented; and 2) arrhythmias if their occurrence increased the risk of ischemia or hemodynamic compromise.

All patients were followed and information on functional status and mortality was obtained by telephone at six months. Additional deaths were identified from hospital records and from vital statistics. Ascertainment of death or functional outcome was available for 94.0% of subjects at 6 months.

We compared patients having surgery within 24 hours to those having surgery after 24 hours on the following outcomes: 1) mean pain scores over the first 5 hospital days; 2) number of days of severe pain over hospital days 1–5; 3) major post-operative complications; 4) length of stay; 5) mortality through six months; 6) FIM locomotion (a 2-item subscale focusing on walking and climbing stairs) score at 6 months; 7) FIM self care (a 6-item scale of self-care activities including bathing and dressing); and 8) FIM transferring (a 3-item scale focusing on transfers from the bed, toilet, and tub). The analyses of complications (n=554) and of pain (n=487 able to report on pain) were limited to subjects enrolled in the first 12 months. Other analyses involved data from all enrolled subjects having surgery. We focused on pain over the first 5 hospital days because we were interested in cumulative pain burden rather than preoperative or postoperative pain which would have been difficult to compare between the early and later surgery groups. For the FIM measures, analyses were restricted to survivors. We excluded patients who were totally or maximally dependent on walking at baseline (n=75) from analyses of FIM locomotion because the scale could not be responsive to worsening in these patients due to a “floor” effect. To test the sensitivity of our results to the exclusion of survivors, we also examined the effect on a combined measure of mortality or needing total assistance in locomotion 22.

To control for factors that affect outcomes and decisions about surgical timing, we used ordinary least squares regression (for continuous outcomes), logistic regression (for binary outcomes), or Cox proportional hazards regression for our main analyses. The analyses controlled for the effects of age, gender, nursing home residence, needing a proxy for consent, delirium on admission, pre-fracture FIM locomotion score, fracture type, hospitalization within 6 months, hospital site, day and time of admission, abnormal clinical findings, and history of diabetes, chronic obstructive pulmonary disease, cerebrovascular accident, dementia, cardiac disease, and hypertension.

We performed two types of supplementary or sensitivity analyses. First, we performed an analysis using propensity scores 23, 24 to match patients in which the likelihood of having early surgery was similar. In the first step, we used stepwise logistic regression to generate a propensity score for having early surgery for each patient using the available variables. Each case of surgery within 24 hours was then matched with a case having later surgery based on the closest propensity score (within 10%) and closest age (when multiple matches were obtained). We compared patients having surgery within 24 hours to matching cases having surgery after 24 hours.

As our second supplementary analysis, we examined whether the results changed with a restricted cohort of patients where we excluded patients who might not be candidates for early surgery because of markedly abnormal clinical findings or the need for additional time for preoperative evaluation. Thus, we excluded patients admitted with abnormal clinical findings, aortic stenosis, dementia, and end-stage renal disease on dialysis.

Results

Twenty-eight (2.3%) of patients did not have surgery and are excluded from the analyses. Of the remaining patients (n=1178), 33.8% (n=398) had surgery 24 hours or less after hospital arrival. Compared to patients who went to surgery within 24 hours, patients who had later surgery (n=780) were less likely to have come from nursing homes ($p<0.05$) and were more likely to have poorly compensated heart failure ($p<0.001$), abnormal INR ($p<0.001$), and other laboratory abnormalities ($p<0.05$) (Table 1). Having surgery within 24 hours also varied by hospital site, by day of the week and time of admission.

The overall unadjusted mortality was 8.2% at 2 months and 17.5% at 6 months (unadjusted hazard ratio for early surgery was 0.68; 95% CI 0.48, 0.97; p=0.031). After adjustment, earlier surgery was not associated with improved mortality (hazard ratio = 0.75; 95% confidence interval 0.52, 1.08; p=0.121). Unadjusted and adjusted results for other outcomes for the main analyses are shown in Table 2. Compared to patients having later surgery, earlier surgery was associated with pain scores (difference of −0.24 points, 95% CI −0.44, −0.06) and number of days of severe pain for the first five days of hospitalization (difference of −0.22 days, 95% CI −0.41, −0.03) that were significantly better. Early surgery was also associated with shorter length of stay by 1.94 days ($p<0.001$) and improved FIM self care (p=0.041), but there was only a trend toward lower complications (p=0.096). FIM locomotion scores did not differ at 6 months (difference of −0.04 points, 95% CI −0.48, 0.39) between the 2 groups. The effects on FIM locomotion was similar when we used different timeframes (surgery within 24 hours, within 24–48, or after 48 hours of arrival) of surgical timing (not shown).

The logistic regression to derive the propensity score had a c-statistic of 0.68. Of the cases with surgery within 24 hours (n=398), 373 (93.7%) were successfully matched. No significant differences were found between the two matched groups for the characteristics listed in Table 1. Earlier surgery was not associated with improved mortality (hazard ratio = 0.98; 95% CI

0.63, 1.50; p=0.909) in propensity-score matched cases. Early surgery was associated with reduced pain and length of stay (Table 3). However, no significant differences were observed in complications and in FIM functional status measures at 6 months.

In the restricted cohort, early surgery continues to be significantly associated with reduced pain and length of stay (Table 2). The difference in number of days of severe pain between the 2 groups was −0.30 days favoring early surgery (95% CI −0.50, −0.08). Additionally, early surgery is also associated with reduced major post-operative complications (p=0.041). Early surgery has no association with functional outcomes or mortality in the restricted cohort.

Discussion

Previous studies have yielded conflicting results on the effect of early surgery on survival in hip fracture, and the effect of early surgery on functional outcomes and pain is unknown. In this study, we found that surgery in the first 24 hours compared to later surgery was not associated with either improved or worsened survival and function at 6 months – a timeframe during which most recovery will occur 3, 4. On the other hand, early surgery was consistently associated with decreased length of stay and less pain and probably with reduced major complications. In an earlier study 25, we reported that clinical reasons (waiting for test results or for medical stabilization) were infrequent reasons for delayed surgery in patients operated on between 24–48 hours. Instead, system problems (timely consultation or availability of the surgeon or operating room) accounted for the majority of cases of delay. Thus, it is feasible to improve surgical timing which could in turn translate to improved efficiency and reductions in severe pain.

In the case of mortality, our finding is consistent with those of a recent study of 8383 patients where no association was found when mortality was compared in early (defined as 24–48 hours) and later surgery 20. Patients with surgery in the first 24 hours were excluded; thus, our study goes beyond that analysis by considering surgical timing from the time of admission—a better test of the early surgery hypothesis. In the case of functional outcomes, several explanations exist for the null finding. First, the benefit could be small. For example, we hypothesized that reduced pain might translate to improved function based on an earlier study 26, but the effect of earlier surgery on reduced pain may be too small or too short in duration to make a difference on function. Second, the functional benefit may be limited to a subgroup of patients and obscured in analyses focusing on the average patient. Third, the benefit from early surgery may be limited and short-lived if it is not followed up by timely mobilization, early rehabilitation 27, and attention to post-acute care.

The strength of this study is that it is the largest study of hip fracture that has detailed clinical information (beyond administrative data and medical records) on the hospital course, as well as information on functional outcomes through 6 months. Nevertheless, our study was limited by reliance on self report for functional status, by reduced statistical power for selected outcomes, and by the observational study design.

In the case of measuring function, we selected our methods knowing that pre-fracture function is an important predictor of outcomes. Since observing function before the fracture is infeasible, a measure that involved reporting of functional status was needed. We selected what we considered to be the most appropriate interview measure given that a considerable fraction of hip fracture patients would need proxy respondents because of dementia or delirium. The literature on proxy respondents indicates that agreement between subjects and proxies is greatest for questions that focus on discrete and observable tasks as is the case with the measures we used, relative to questions that may ask about perceived limitations in doing those tasks.

For functional outcomes, the confidence interval on the FIM locomotion scale showed that it is unlikely that early surgery improved or worsened locomotion by more than half a point, and we believe that clinically significant differences were excluded. As an illustration of the meaning of a 2-point difference on this scale, consider that a patient with a pre-fracture FIM locomotion of 6 had a predicted 6-month mortality rate of 21% compared to a mortality rate of 15% for patients with 8 points. In the case of mortality, our study showed that an unadjusted association between early surgery and improved mortality diminished after adjustment for other risk factors and that the benefit was largely eliminated in analyses involving propensity score matching or a restricted cohort. Although we could not exclude a moderately large benefit, the confidence interval (0.52, 1.08 for the hazard ratio) in the main adjusted analysis indicates that anything more than a small detrimental effect from early surgery is unlikely. Finally, we showed that early surgery was consistently associated with shortened length of stay and reduced pain. The clinical significance of a reduced pain score can be understood by looking at the number of fewer days of severe pain (0.22–0.30 days or 5–7 fewer hours of severe pain on average). We would argue that this is a clinically significant difference.

Although our study was observational, we attempted to control for selection in several ways. First, our analyses adjusted for a range of variables used by clinicians to select patients for early surgery. These measures go beyond those available from administrative data and include information on function collected from interviews. Second, we also used propensity score methods to match cases of early and late surgery. Finally, we repeated our analyses excluding patients that might not be appropriate candidates for early surgery. Given that a randomized trial of early versus delayed surgery is not likely to be done, we believe that this important clinical question can only be answered by careful observational research methods.

In conclusion, early surgery alone does not appear to have a beneficial effect on mortality or function for the average patient with hip fracture. However, early surgery was associated with less pain, reduced length of stay, and probably fewer major complications. Further studies are needed that focus on the functional impact of early surgery on subgroups of patients. Additionally, research is needed on whether the theoretical benefits of early surgery on functional outcomes may be achieved when early surgery is combined with the timely provision of mobilization, rehabilitation, and the full range of post-acute medical services. In the meantime, early surgery should be a goal for the majority of patients with hip fracture who present to the hospital with stable medical problems given that adverse events are unlikely and that pain, length of stay, and possibly complications will be reduced.

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Table 1

Characteristics of Patients with Hip Fracture

	(Surgery ≤24hours N=398)	Surgery >24hours (N=780)	No surgery (N=28)
Mean age	82	82	79
Female	316(79%)	633(81%)	21(75%)
Admit delirium	10 (3)	20 (3)	2 (7)
Informed consent by pt.	276(69)	536 (69)	15(54)
Nursing home	63(16)	90 (12)‖	1(4)
Mean FIM locomotion score*	10.8	10.1	8.6**
Femoral neck fracture	195 (49)	373 (48)	17(61)
Medical history:			
Diabetes	56 (14)	135 (17)	6(21)
COPD	44 (11)	104 (13)	5(18)
Stroke	39 (10)	97 (12)	6 (21)
Dementia	90 (23)	163 (21)	5 (18)
Cardiac history†	124 (31)	305 (39)¶	12(43)
Hypertension	223 (56)	425 (54)	16 (57)
Hospitalized in past 6 months	28 (7)	62 (8)	2 (7)
Abnormal clinical findings:			
Blood pressure abnormality	4 (1)	4 (1)	0 (0)
Rate or rhythm abnormality	4 (1)	11 (1)	0 (0)
Recent chest pain or MI	2 (1)	15 (2)**	1 (4) ¶
Poorly compensated heart failure	50 (13)	174 (22)**	9 (32)) ¶
Abnormal INR	23 (6)	102 (13)‖	5 (18))**
Laboratory abnormality‡	48 (12)	133 (17)**	10 (36)
System factors			
Admitted to hospital B	147 (37)	211 (27)‖	10 (36)
Admitted on Thursday	67 (17)	93(12)**	5(18)
Admitted 6AM-noon	57(14)	219(28)	8(29)‖

*2 item scale with each item ranging from 1 (completely dependent) to 7 (completely independent)

†includes a history of valvular heart disease, coronary heart disease, arrhythmia, or congestive heart failure

‡Abnormality in electrolytes, BUN, glucose, hemoglobin, or blood gases

‖p≤.05 (compared to group with surgery in ≤ 24 hours)

¶p ≤.01 (compared to group with surgery in ≤ 24 hours)

**p ≤.001 (compared to group with surgery in ≤ 24 hours)

Table 2

adjusted outcomes: Patients with surgery in <24 hours compared to those with later surgery *

Unadjusted Outcomes (Standard Deviation)			Adjusted Outcomes†				Restricted Cohort			
Surgery ≤24 hours	Surgery >24 hours	P	Surgery ≤24 hours	Surgery >24 hours	Difference or OR (95% CI)	P	Surgery ≤24 hours	Surgery >24 hours	Difference or OR (95% CI)	P
2.47 (1.03)	2.96 (0.96)	<0.001	2.63	2.87	−0.24 (−0.44, −0.06)	0.010	2.52	2.90	−0.38 (−0.61, −0.16)	.001
0.53 (0.76)	0.92 (1.01)	<0.001	0.64	0.86	−0.22 (−0.41, −0.03)	0.025	0.50	0.80	−0.30 (−0.50, −0.08)	0.007
5.4%	10.3%	0.064	3.96%	7.97%	OR = 0.50 (0 22,1.13)	0.096	1.8%	7.5%	OR = 0.24 (0.06,0.96)	0.041
7.07 (4.92)	9.43 (8.18)	<0.001	7.35	9.29	−1.94 (−2.82, −1.06)	<0.001	6.94	7.85	−0.91 (−1.81, −0.01)	0.047
9.22 (3.71)	8.95 (3.74)	0.306	8.81	8.85	−0.04 (−0.49,0.39)	0.843	9.94	9.97	−0.03 (−0.60,0.54)	0.911
32.0 (10.53)	31.8 (10.08)	0.814	30.3	31.4	−1.1 (−2.18, −0.04)	0.041	34.8	35.4	−0.60 (−1.98,0.65)	0.325
14.2 (5.32)	14.1 (5.14)	0.763	13.6	13.9	−0.3 (−0.92,0.25)	0.259	15.7	15.7	0 (−0.64,0.77)	0.852
22.4%	27.3%	0.090	23.0%	27.3%	OR = 0.84 (0.59,1.21)	0.360	8.0%	13.7%	OR = 0.58 (0.31,1.09)	0.092

ecause of data availability (pain and complications only in patients enrolled in first 12 months), ability to self report in the case of pain, and patients lost to follow up or missing data at 6 487, 487, 554, 1178, 890, 914, 922, and 1037 respectively for the unadjusted and adjusted results. N=261, 261 273 566, 465, 470, 476, and 509 respectively for the restricted cohort.

or age, gender, nursing home residence, needing a proxy for consent, delirium on admission, pre-fracture FIM locomotion score, fracture type, history of diabetes, chronic obstructive disease, cerebrovascular accident, dementia, cardiac disease, hypertension, hospitalization within 6 months, hospital site, day and time of admission, and abnormal clinical (physical exam ory) findings

ain variable 0 (none) – 5 (very severe pain)

ludes survivors only

Table 3

Comparison of outcomes for pairs of patient having surgery in ≤24 hours and having surgery > 24 Hours matched using a propensity score for earlier surgery

	Surgery ≤24 hours	Surgery >24 hours	Difference or OR (95% CI)	P
Mean pain score hospital day 1–5 * (n=123 pairs out of 146 possible matches) †	2.56	2.86	−0.30 (−0.54, −0.56)	.016
Number days of severe pain hospital day 1–5 (n=123 pairs out of 146 possible matches)	0.58	0.87	−0.29 (−0.51, −0.06)	.013
Major post-operative complication (n=145 pairs out of 163 possible matches)	3.60%	4.88%	OR = 0.74 (0.26,2.07)	.565
Mean length of stay in days (n=373 pairs out of 398 possible matches)	7.12	8.58	−1.46 (−2.25, −0.66)	.000
FIM locomotion at 6 months ‡ (n=296 pairs out of 314 possible matches)	9.40	9.26	0.14 (−0.35,0.64)	.559
FIM self care at 6 months ‡ (n=299 pairs out of 316 possible matches)	32.33	33.37	−1.04 (−2.19,0.13)	.081
FIM transferring at 6 months ‡ (n=302 pairs out of 320 possible matches)	14.40	14.90	−0.50 (−1.15,0.15)	.132
Combined outcome -- dead or needing total assistance in locomotion at 6 months (%) (n=302 pairs out of 320 possible matches)	18.49%	19.52%	OR = 0.95 (0.61,1.46)	.807

* Range of pain variable 0 (none) – 5 (very severe pain)

† Number of possible matches varies because of data availability (pain and complications only in patients enrolled in first 12 months), ability to self report in the case of pain, and variable number of patients with missing data at 6 months

‡ Model includes survivors onl