# Analysis of Risk Factors Associated with Early Post-Operative Mortality and Morbidity of Hip Fracture Surgery in the Elderly Patients

## Yaşlı Hastalarda Kalça Kırığı Cerrahisi Sonrası Erken Postoperatif Mortalite ve Morbiditeyi Etkileyen Risk Faktörlerinin Analizi

Işıl DAVARCI,[a]
Onur KOYUNCU,[a]
Murat KARCIOĞLU,[a]
Kasım TUZCU,[a]
Sedat HAKİMOĞLU,[a]
Raif ÖZDEN,[b]
Ali SARI,[a]
Selim TURHANOĞLU[a]

Departments of
[a]Anesthesiology and Reanimation,
[b]Orthopedics and Traumatology,
Mustafa Kemal University
Faculty of Medicine, Hatay

Geliş Tarihi/*Received:* 20.01.2014
Kabul Tarihi/*Accepted:* 28.04.2014

Yazışma Adresi/*Correspondence:*
Işıl DAVARCI
Mustafa Kemal University
Faculty of Medicine,
Department of Anesthesiology and
Reanimation, Hatay,
TÜRKİYE/TURKEY
isildavarci@gmail.com

**ABSTRACT Objective:** In this retrospective study, it was aimed to evaluate factors influencing morbidity and mortality at early period after hip fracture surgery in elder patients. **Material and Methods:** We retrospectively analyzed 171 patients older than 60 years who underwent hip fracture surgery in a 3-years period. Data about the clinical characteristics of patients were extracted from hospital records. Primary outcome was defined as mortality rate within postoperative 30 days, while secondary outcome as mortality rate within postoperative first week. Morbidity on the day 7 was calculated as tertiary outcome. To identify factors influencing morbidity and mortality, parameters found to be significant in univariate analysis were evaluated with Binary Logistic Regression analysis. **Results:** According to the univariate analysis, the factors which significantly increased mortality were age, comorbid disease, American Society of Anesthesiologists (ASA) physical status, anesthesia technique (general anesthesia), cement and intraoperative inotropic use. In Binary Logistic Regression analysis, ASA physical status, intraoperative inotropic use and anesthesia technique were found as factors that significantly increased mortality. No significant difference was found in 7 and 30-day mortality rates among non-survivors. **Conclusion:** It was concluded that main factors determining early mortality are general anesthesia technique, intraoperative inotropic use and high ASA risk classification. Further studies are needed to determine how survival and functional recovery could be improved.

**Key Words:** Aged; morbidity; hip fractures; anesthesia

**ÖZET Amaç:** Bu retrospektif çalışmada, yaşlı hastalarda kalça kırığı cerrahisi sonrası erken dönem mortalite ve morbiditeye etki eden faktörlerin incelenmesi amaçlanmıştır. **Gereç ve Yöntemler:** Kalça kırığından opere olan 60 yaş üstü 171 hasta üç yıllık dönemde retrospektif olarak analiz edildi. Hastalarla ilgili tüm veriler hastane kayıtlarından elde edildi. Çalışmamızın birincil sonucu ameliyat sonrası 30 gün, ikincil sonucu ise ameliyat sonrası 7 gün içinde ölüm oranı olarak tanımlandı. Morbidite verileri postoperatif 7. günde üçüncül sonuç olarak değerlendirildi. Mortalite ve morbiditeye etkili faktörlerin ortaya konulması için univaryat analizlerde anlamlı çıkan değişkenler Binary Logistic Regression modelinde incelendi. **Bulgular:** Univaryat analize göre mortaliteyi anlamlı olarak arttıran faktörler başlıca yaş, eşlik eden hastalıklar, ASA, anestezi yöntemi (genel anestezi), sement ve intraoperatif inotropik destek kullanımı olmuştur. Binary Logistic Regression analizinde ise Amerikan Anesteziyolojistler Birliği (ASA), intraoperatif inotropik destek kullanımı ve anestezi yöntemi anlamlı derecede mortaliteyi arttıran faktörler olmuştur. Ölen hasta grubunda 7 ve 30 gün mortalite oranları arasında anlamlı farklılık görülmemiştir. **Sonuç:** Erken mortalitede en belirleyici faktörlerin genel anestezi yöntemi, intraoperatif inotropik destek kullanımı ve yüksek ASA risk sınıflaması olduğu sonucuna varıldı. Sağkalım ve fonksiyonel iyileşmenin nasıl geliştirilebileceği ile ilgili daha ileri çalışmalara ihtiyaç vardır.

**Anahtar Kelimeler:** Yaşlı; morbidite; kalça kırıkları; anestezi



**Turkiye Klinikleri J Anest Reanim 2014;12(2):82-8**

Hip fracture is a common health problem among elder individuals, which has an increasing incidence due to prolonged mean life expectancy and causes tremendous economical cost to public and poorer quality of life with high perioperative mortality and morbidity. These patients are generally elder, frail and have low physiological reserves as well as chronic comorbid diseases and cognitive dysfunction. At time of admission, these patients generally have concurrent medical problems that can affect prognosis.[1]

Hip fracture surgery is a widely performed medical procedure in these patients. Presence of multiple comorbid conditions contributes to perioperative morbidity and mortality in surgical procedures. In several studies, it was demonstrated that 30-day mortality rate of 5-10% increases up to 37% within one year after surgery.[2-4] In procedures performed in high-risk patients, identification and management of factors contributing to perioperative morbidity and mortality are always challenging for clinicians.[5]

Despite advances in surgical and anesthetic techniques in last two decades no decrease has been observed in the mortality of hip fracture surgery. Perioperative morbidity is usually multifactorial in surgical procedures.[6] In addition to surgical procedure itself, anesthesia technique preferred, toxicity of anesthetic agent used, and incidence of intraoperative and postoperative events should be taken into account in the assessment of postoperative mortality and morbidity risk.[7]

In this retrospective study, it was aimed to identify major factors influencing early mortality and morbidity in elder patients undergoing repair for hip fracture; thus, to determine formulas for decreasing mortality and morbidity.

## MATERIAL AND METHODS

In this study, factors influencing postoperative morbidity and mortality were retrospectively reviewed in patients aged 60 years or older who underwent hip prosthesis due to hip fracture between 1 January, 2010 and 1 January, 2013 at Orthopedics & Traumatology Department of Mustafa Kemal University, Medicine School. The study was approved by Institutional Ethics Committee.

Medical records of 171 patients were extracted by screening for patients who underwent surgery due to unilateral hip fracture during 3-years period. Demographic characteristics (age, gender, weight, comorbid diseases, American Society of Anesthesiologists (ASA) physical status, anticoagulant prophylaxis, medication), surgical data (anesthesia technique, transfusion need, cement use, need for intraoperative inotropic support use), morbidity, length of hospital stay, and 7- and 30-day mortality rates were recorded.

### PRIMARY OUTCOME: 30-DAY MORTALITY

The primary outcome was defined as mortality rate within first 30 days after surgery. This is considered as the standard period in the assessment of peri-operative results.[7]

### SECONDARY OUTCOME: 7-DAY MORTALITY

We used 7-day mortality as secondary outcome, since it can effectively represent complications related to anesthesia at early postoperative period.

### TERTIARY OUTCOME: MORBIDITY

As it can be difficult to assess complications after discharge and anesthesia-related complications occur at early postoperative period, we assessed morbidity during hospital stay. The morbidity outcomes were postoperative sudden cardiac arrest, myocardial infarction, congestive heart failure, postoperative pneumonia, pulmonary thromboembolism, respiratory failure, atelectasis, urinary complications, hepatic failure, gastro-intestinal failure, deep major infections, sepsis, hematoma, fever, delirium (change in mental status) and surgical complication.

### STATISTICAL ANALYSIS

All statistical analyses were performed by using SPSS for Windows version 18.0. Both descriptive and analytic statistics were used. Chi-square/ Fischer's test was used for comparisons between categorical variables. Normal distribution of

continues variables were tested with Kolmogorov-Smirnov test. Mann Whitney U test was used for comparisons between groups. Factors found to have effect on mortality and morbidity in univariate analysis were evaluated with Binary Logistic Regression analysis. $p<0.05$ was considered as statistically significant in all analysis.

## RESULTS

In this study, 171 patients with available data who underwent surgery for hip fracture during past 3-years period were evaluated. Table 1 presents relationship between main descriptive variables and mortality based on univariate analysis. Significant risk factors for mortality were age, ASA physical status, comorbidity, cement implementation, intraoperative inotropic support and type of anaesthesia. Mean age (78 years) was significantly higher in non-survivors than survivors whereas there was no significant difference in gender between survivors and non-survivors. In addition, it was found that non-survivors had higher ASA physical status and rate of multiple comorbid conditions (two and three or more). When mortality rate was assessed according to anesthesia technique, it was found that significant proportion of non-survivors was in general anesthesia group ($p<0.036$).

**TABLE 1:** Relationship between main explanatory variables and mortality according to Univariate analysis (p values from chi-square test). Values were presented as number of patients (percentage) for nominal data and as median for data in scales.

| | Survivors (n=157) | Nonsurvivors (n=14) | P |
|---|---|---|---|
| Age (year) | 74 (61-106) | 78 (71-95) | 0.014* |
| Male | 97 (62) | 5 (36) | 0.057 |
| Female | 60 (38) | 9 (64) | |
| Living at home | 51 (32.5) | 7 (50) | 0.185 |
| Other health institue | 106 (67.5) | 7 (50) | |
| ASA physical status | | | |
| I | 12 (7.6) | 0 (0) | 0.0001* |
| II | 52 (33.1) | 0 (0) | |
| III | 62 (39.5) | 4 (28.6) | |
| IV | 31 (19.7) | 10 (71.4) | |
| No of comorbidities | | | |
| 0 | 12 (7.6) | 0 (0) | 0.0001* |
| 1 | 52 (33.1) | 0 (0) | |
| 2 | 84 (53.5) | 5 (35.7) | |
| ≥3 | 9 (5.7) | 9 (64.3) | |
| Medication | 136 (86.6) | 14 (100) | 0.222 |
| Anticoagulant prophylaxis | 123 (78.3) | 13 (92.9) | 0.305 |
| Cement implementation | 107 (68.2) | 14 (100) | 0.011* |
| Intraoperative inotropic support | 74 (47.1) | 13 (92.9) | 0.001* |
| Type of Anesthesia | | | |
| General | 101 (64.3) | 13 (92.9) | 0.036* |
| Spinal | 47 (29.9) | 1 (7.1) | |
| Epidural | 9 (5.7) | 0 (0) | |
| Lenght of hospital stay | 8 (2-25) | 8.5 (3-30) | 0.912 |
| 7 days mortality | 68 (43.3) | 7 (50) | 0.629 |
| 30 days mortality | 89 (56.7) | 7 (50) | |
| Intraoperative blood tranfusion (ml) | 113 (72) | 6 (42.9) | 0.242 |

ASA: American Society of Anesthesiologists; * P<0.05.

Intraoperative cement was used in all non-survivors, while it was used more than half of survivors, indicating significant difference between survivors and non-survivors (p<0.011). Likewise, intraoperative inotropic use was significantly higher among non-survivors (p<0.001). It was seen that 7- and 30-day mortality rates were similar among non-survivors (p<0.629).

Table 2 presents association between main descriptive variables and mortality based on binary logistic regression analysis.

Table 3 presents comorbid conditions and morbidity incidence. It was found that hypertension was most common comorbid disease in both groups, while there was marked increase in the incidences of coronary artery disease, chronic obstructive pulmonary disease, diabetes mellitus and neurological disorder (Table 3).

There was no significant difference in postoperative morbidity rate between survivors and non-survivors regarding cardiovascular, respiratory, urinary and surgical complications, hepatic and gastrointestinal failure as well as major infection, fever, delirium and hematoma (Table 3).

**TABLE 2:** The association between main descriptive variables and mortality based on binary logistic regression analysis.

| Risk Factors | OR (95% CI) | p |
|---|---|---|
| Age (year) | 1.04 (0.93-1.15) | 0.468 |
| Cement implementation | 2.21 (0.00-384.24) | 0.997 |
| Intraoperative inotropic support | 22.80 (2.26-229.51) | 0.008* |
| Type of Anesthesia$^{\alpha}$ | 0.076 (0.00-0.68) | 0.021* |
| Comorbidities$^{\#}$ | 4.868 (0.41-57.66) | 0.210 |
| ASA 4 | 6.207 (1.36-28.15) | 0.018* |

* p<0.05.

OR: Odds Ratio; CI: Confidence Interval; ASA: American Society of Anesthesiology.

$^{\alpha}$: General aneshesia; $^{\#}$: 2 or more comorbidity.

**TABLE 3:** Comorbidity and postoperative complications in survivors and non-survivors with hip fracture. Values were presented as number of patients (percentage).

| | Survivors (n=157) | Non-survivors (n=14) |
|---|---|---|
| Comorbidity | | |
| Coronary artery disease | 39 (24.8) | 8 (57.1) |
| Hypertension | 95 (60.5) | 12 (85.7) |
| Chronic obstructive pulmonary disease | 7 (4.4) | 9 (64.2) |
| Diabetes mellitus | 11 (7) | 5 (35.7) |
| Neurological disorders | 4 (2.5) | 7 (50) |
| Other medical disorders | 94 (59.8) | 3 (21.4) |
| Postoperative complications | | |
| Cardiovascular complication | 134 (85.4) | 14 (100) |
| Respiratory complication | 127 (80.9) | 13 (92.9) |
| Urinary complication | 48 (30.6) | 1 (7.1) |
| Gastrointestinal failure | 0 (0) | 1 (7.1) |
| Hepatic failure | 0 (0) | 1 (7.1) |
| Surgical complication | 12 (7.6) | 1 (7.1) |
| Hematoma | 11 (7) | 2 (14.3) |
| Deep wound infection | 57 (36.3) | 4 (28.6) |
| Fever | 56 (35.7) | 4 (28.6) |
| Delirium | 62 (39.5) | 8 (57.1) |

## DISCUSSION

In our study, logistic regression analysis demonstrated that ASA physical status, general anesthesia and intraoperative inotropic use were associated with significant increase in mortality risk.

In our study, data were evaluated by univariate regression analysis first to assess raw effects of variables on mortality and morbidity.

Based on results, factors causing increased mortality were age, comorbid diseases, ASA physical status, anesthesia technique (general anesthesia), cement use and intraoperative inotropic support use.

In the literature, there are several studies investigating mortality and morbidity rates and related-factors after hip fracture.[8-10] In clinical trials, it has been suggested that advanced age, cardiovascular disease, pulmonary disease, diabetes mellitus and poor general health status are associated with increased risk of mortality.[11-13] Toruella et al. reported that mortality rate was 16.5% in control group while it was increased up to 40% in patient group.[14] Mc Leod et al. reported that age, gender, general health status and condition were primary factors that increase mortality in their study, in which one-year mortality rate was found as 29%.[11]

Jiang et al. found one-year mortality as 37.5% in men and 28.2% in women. Authors suggested that advanced age, male gender, better health status and presence of comorbid disease resulted in high mortality rate .[15] In a study by Alegre-Lopez et al., it was concluded that high mortality rate was associated with functional failure before fracture, poor mental status, age (≥80 years) and female gender.[16] In our study, a significant increase was detected in mortality rate in advanced age group. In addition, mortality was also higher among women, but the difference didn't reach statistical significance.

Hip fracture is associated with high mortality and decreased or worsened functional outcomes. In patients with hip fracture, high ASA scores are often observed due to advanced age and comorbid conditions.[17] Atay et al. concluded that presence of comorbid conditions largely affected mortality in patients with high ASA scores who died within one year.[17] In the study by Roche et al., following conditions were detected as comorbidity factors: cardiovascular diseases, plegia, respiratory system diseases, renal failure, diabetes mellitus, rheumatologic disorders, Parkinson disease, cancer, Paget's disease, smoking and enteral steroid use. Authors also reported that presence of 3 or more comorbid conditions were associated with high mortality. In addition, they reported that striking finding of the study is that the number and type of comorbid diseases at baseline were determinants of mortality in patients with hip fracture.[13]In our study, rate of comorbid disease was higher in the group with higher mortality rate and presence of 2 or more comorbid diseases significantly increased mortality.

ASA classification is widely used in predicting short- and long-term mortality.[18-20] Hamlet et al. reported that ASA classification assessing preoperative health status was associated with postoperative mortality and late functional outcomes. In that study, it was reported that ASA classification was a good predictor and that 3-year mortality was significantly lower in ASA I-II patients (%23) when compared to ASA III patients (39%).[21] In the study by Donegan et al., it was demonstrated that ASA classification is a helpful parameter to assess general health status of patient and that it might a strong predictor of perioperative medical complications after hip fracture surgery.[22] These findings together highlight ASA classification as a good predictor of mortality. In our study, 30-day mortality rate was 100% in ASA III-IV patients. It was found that the difference among survivors was significantly increased. In a study, in which postoperative outcomes were assessed according to anesthesia type used, Şahin et al. reported that 30-day mortality was higher in patients with ASA ≥ III (87.5%) but the difference didn't reach statistical significance.[5]

General or regional anesthesia techniques are widely used in hip fracture surgery.[23] There are contradictory results in many studies which investigated whether anesthesia types affect mortality and morbidity.[17,24-27] Atay et al. found that anesthesia type had no effect on 1- or 2-year mortality.[17] Dzupa et al. reported that mortality rates were similar within one year after spinal and general anesthesia.[27] Şahin et al. concluded that anesthesia technique had no effect on postoperative mortality in elder patients undergoing hip surgery.[5] On contrary, in a meta-analysis of randomized studies which compared general and regional anesthesia in patients with hip fracture, Urwin et al. suggested that regional anesthesia markedly decreased risk for early mortality and deep venous thrombosis.[23] However, Parker et al. suggested that regional anesthesia decreased early mortality but this finding didn't necessarily draw conclusion for long-term.[28] In our study which assessed factors affecting risk for short-term mortality, it was found that regional anesthesia significantly affected survival when compared to general anesthesia. As hip fracture surgery is being performed in elder patients, it is obvious that any anesthesia technique will not provide survival advantage in long-term.[17] Thus, it is recommended that one should prefer most appropriate anesthesia technique for an individual patient as both regional and general anesthesia technique will produce comparable results.[7]

Cement use is common in elder patients with hip fracture, which is thought to provide stronger and accelerated mobilization than hip prosthesis.[29]

However, fat or bone marrow content emboli to lungs can be encountered during cement applications.[30] Yli-Kyyny et al. found that cardiovascular disorder was less common and early mortality rate was lower in procedures not using cement in the study in which incidence of perioperative cardiovascular disorder was compared in patients with hip fracture undergoing arthroplasty with or without cement.[29] In a systematic review by Ahn et al., it was suggested that cement use caused increased risk for perioperative mortality.[31] In our study, cement was used in all non-survivors. We also found that there was a significant increase in the risk for 30-day mortality.

Furthermore, in patients undergoing hip arthroplasty, intraoperative hemodynamic changes that were caused by poorer general health status in most of patients due to comorbid diseases, increased incidence of cardiovascular diseases, general or regional anesthesia and usage of cement may surpass an intolerable level.[32] Thus, in this condition intraoperative vasopressor use is inevitable. Ohara et al., found increased incidence of hypotension, vasopressor use and arrhythmia in regional anesthesia group; however, these factors didn't increase mortality and morbidity.[7] In our study, inotropic support use was significantly higher among non-survivors when compared to survivors.

In the final stage, parameters found to be significant in univariate analysis were included into binary logistic regression analysis in our study. Based on binary logistic regression analysis, it was concluded that the strongest determinants of early mortality included general anesthesia, intraoperative inotropic support use due to frequent hemodynamic changes and intolerance to these changes and higher ASA classification.

## CONCLUSION

In conclusion that, although risk factors related to mortality are multifactorial and inevitable, well-designed prospective, randomized studies are needed for establishing ways to improve survival and functional recovery.

## REFERENCES


1. Saltvedt I, Prestmo A, Einarsen E, Johnsen LG, Helbostad JL, Sletvold O. Development and delivery of patient treatment in the Trondheim Hip Fracture Trial. A new geriatric in-hospital pathway for elderly patients with hip fracture. BMC Res Notes 2012;5:355.
2. Parker M, Johansen A. Hip fracture. BMJ 2006;333(7557):27-30.
3. Morrison RS, Chassin MR, Siu AL. The medical consultant's role in caring for patients with hip fracture. Ann Intern Med 1998;128(12 Pt 1):1010-20.
4. Lyons AR. Clinical outcomes and treatment of hip fractures. Am J Med 1997;103(2A):51S-63S; discussion 63S-64S.
5. Şahin SH, Heybeli N, Çolak A, Arar C, Alan K, Çopuroğlu C, et al. Comparison of different anesthetic techniques on postoperative outcomes in elderly patients with hip fracture. Turkiye Klinikleri J Med Sci 2012;32(3): 623-9.
6. Foss NB, Kehlet H. Mortality analysis in hip fracture patients: implications for design of future outcome trials. Br J Anaesth 2005;94(1): 24-9.
7. O'Hara DA, Duff A, Berlin JA, Poses RM, Lawrence VA, Huber EC, et al. The effect of anesthetic technique on postoperative outcomes in hip fracture repair. Anesthesiology 2000;92(4):947-57.
8. Geiger F, Schreiner K, Schneider S, Pauschert R, Thomsen M. [Proximal fracture of the femur in elderly patients. The influence of surgical care and patient characteristics on post-operative mortality]. Orthopade 2006;35 (6):651-7.
9. Kenzora JE, McCarthy RE, Lowell JD, Sledge CB. Hip fracture mortality. Relation to age, treatment, preoperative illness, time of surgery, and complications. Clin Orthop Relat Res 1984;(186):45-56.
10. Lu-Yao GL, Baron JA, Barrett JA, Fisher ES. Treatment and survival among elderly Americans with hip fractures: a population-based study. Am J Public Health 1994;84(8):1287-91.
11. McLeod K, Brodie MP, Fahey PP, Gray RA. Long-term survival of surgically treated hip fracture in an Australian regional hospital. Anaesth Intensive Care 2005;33(6):749-55.
12. Franzo A, Francescutti C, Simon G. Risk factors correlated with post-operative mortality for hip fracture surgery in the elderly: a population-based approach. Eur J Epidemiol 2005; 20(12):985-91.
13. Roche JJ, Wenn RT, Sahota O, Moran CG. Effect of comorbidities and postoperative complications on mortality after hip fracture in elderly people: prospective observational cohort study. BMJ 2005;331(7529):1374.
14. Brossa Torruella A, Tobias Ferrer J, Zorrilla Ribeiro J, López Borras E, Alabart Teixidó A, Belmonte Garridof M. [Mortality after hip fracture: a three year follow-up study]. Med Clin (Barc) 2005;124(2):53-4.
15. Jiang HX, Majumdar SR, Dick DA, Moreau M, Raso J, Otto DD, et al. Development and initial validation of a risk score for predicting in-hospital and 1-year mortality in patients with hip fractures. J Bone Miner Res 2005;20(3):494-500.
16. Alegre-López J, Cordero-Guevara J, Alonso-Valdivielso JL, Fernández-Melón J. Factors associated with mortality and functional disability after hip fracture: an inception cohort study. Osteoporos Int 2005;16(7):729-36.

17. Atay T, Ceylan Gokce B, Ozmeric A, Eroglu F, Yavuz L, Heybeli N, et al. The effects of related factors on one- and two-year mortality after a hip fracture in elderly Turkish patients. Trakya Univ Tıp Fak Derg 2010;27(2):127-31.
18. Wolters U, Wolf T, Stützer H, Schröder T. ASA classification and perioperative variables as predictors of postoperative outcome. Br J Anaesth 1996;77(2):217-22.
19. Prause G, Ratzenhofer-Comenda B, Pierer G, Smolle-Jüttner F, Glanzer H, Smolle J. Can ASA grade or Goldman's cardiac risk index predict peri-operative mortality? A study of 16,227 patients. Anaesthesia 1997;52(3):203-6.
20. Bjorgul K, Novicoff WM, Saleh KJ. American Society of Anesthesiologist Physical Status score may be used as a comorbidity index in hip fracture surgery. J Arthroplasty 2010;25(6 Suppl):134-7.
21. Hamlet WP, Lieberman JR, Freedman EL, Dorey FJ, Fletcher A, Johnson EE. Influence of health status and the timing of surgery on mortality in hip fracture patients. Am J Orthop (Belle Mead NJ) 1997;26(9):621-7.
22. Donegan DJ, Gay AN, Baldwin K, Morales EE, Esterhai JL Jr, Mehta S. Use of medical comorbidities to predict complications after hip fracture surgery in the elderly. J Bone Joint Surg Am 2010;92(4):807-13.
23. Urwin SC, Parker MJ, Griffiths R. General versus regional anaesthesia for hip fracture surgery: a meta-analysis of randomized trials. Br J Anaesth 2000;84(4):450-5.
24. Yeager MP, Glass DD, Neff RK, Brinck-Johnsen T. Epidural anesthesia and analgesia in high-risk surgical patients. Anesthesiology 1987;66(6):729-36.
25. Rodgers A, Walker N, Schug S, McKee A, Kehlet H, van Zundert A, et al. Reduction of postoperative mortality and morbidity with epidural or spinal anaesthesia: results from overview of randomised trials. BMJ 2000; 321(7275):1493.
26. Parker MJ, Handoll HH, Griffiths R. Anaesthesia for hip fracture surgery in adults. Cochrane Database Syst Rev 2004;(4): CD000521. 10.1002/14651858.CD000521.pub2
27. Dzupa V, Bartonícek J, Skála-Rosenbaum J, Príkazský V. [Mortality in patients with proximal femoral fractures during the first year after the injury]. Acta Chir Orthop Traumatol Cech 2002;69(1):39-44.
28. Parker MJ, Unwin SC, Handoll HH, Griffiths R. General versus spinal/epidural anaesthesia for surgery for hip fractures in adults. Cochrane Database Syst Rev 2000;(4): CD000521.
29. Yli-Kyyny T, Ojanperä J, Venesmaa P, Kettunen J, Miettinen H, Salo J, et al. Perioperative complications after cemented or uncemented hemiarthroplasty in hip fracture patients. Scand J Surg 2013;102(2):124-8.
30. Herndon JH, Bechtol CO, Crickenberger DP. Fat embolism during total hip replacement. A prospective study. J Bone Joint Surg Am 1974;56(7):1350-62.
31. Ahn J, Man LX, Park S, Sodl JF, Esterhai JL. Systematic review of cemented and uncemented hemiarthroplasty outcomes for femoral neck fractures. Clin Orthop Relat Res 2008;466(10):2513-8.
32. Yavuz L, Eroğlu F, Ceylan BG, Uçar A, Mumcu EF. [The effects of cemental hip prostheses on core temperature and hemodynamic changes in geriatric patients]. Süleyman Demirel Üniversitesi Tıp Fakültesi Dergisi 2004;11(1):10-4.