Acta Chir Orthop Traumatol Cech. 88, 2021, No. 1
p. 28–34

ORIGINAL PAPER
PŮVODNÍ PRÁCE

# Causes for Delay to Surgery in Hip Fractures and How It Impacts on Mortality: a Single Level 1 Trauma Center Experience

## Příčiny odkladu operace u zlomenin proximálního femuru a jak ovlivňují mortalitu: zkušenost traumacentra 1. stupně

**A. KRISTAN, S. OMAHEN, M. CIMERMAN**

Division of Surgery, Department of Traumatology, University Medical Centre, Ljubljana, Slovenia

## ABSTRACT

PURPOSE OF THE STUDY

The increasing number of hip fractures puts enormous demand on our level 1 trauma centre. Because we have to synchronize hip fracture treatment with all other injuries delays to surgery can occur. In this study, we analysed the reasons for delay to surgery and how it impacts on mortality of hip fracture patients in our institution.

MATERIAL AND METHODS

We retrospectively studied 641 patients operated for hip fractures in one year period. Investigated characteristics were: age, gender, American Society of Anaesthesiologists score (ASA), time of hospital admission, time of surgery, type of surgery, anticoagulant therapy (ACT) and non-routine pre-operative tests (NRPT). Trochanteric (TF) and femoral neck fractures (FNF) were analysed separately. The surgery in first 48 hours was considered early. The time of death was obtained from the federal database. Univariate and multivariable analysis were performed. P-values <0.05 were considered statistically significant.

RESULTS

All tested characteristics were significantly different in both time groups. Delay to surgery was significantly influenced by the type of surgery – arthroplasty, odds ratio (OR) 17.2, ACT (OR 6.9) and NRPT (OR 4.0) in FNF group of patients and by ACT (OR 31.1) and ASA (OR 2.2) in TF. 30-day mortality rate was 5.1% and 1-year mortality was 18.4%. ASA (OR 1.9), preinjury residence (OR 1.4) and age (OR 1.1) had statistical influence on survival, but not delay to surgery.

CONCLUSIONS

The majority of delays are due to unavailability of operative capacities, after patient optimization. We see solution in dedicated operation rooms and teams for hip fracture treatment. Mortality is influenced by the patients' characteristics, but not by delay to surgery. A multidisciplinary approach and skilled surgical teams are, besides early operation, the most important assurance of a good outcome.

**Key words:** trochanteric fracture, femoral neck fracture, timing, mortality.

## INTRODUCTION

Early treatment of hip fractures is uniformly accepted, despite the literature being sometimes confusing and even conflicting (20). Recommendations for timing for hip fracture surgeries vary from 24 hours up to 72, but 36- to 48-hour limitations are mostly accepted in many national guidelines together with preoperative procedures, recommendations for operative treatment and postoperative care (8, 9). Some studies have reported that a prolonged time until surgery increases mortality (10, 29), other studies claim that a delay to surgery has no influence on survival but influences medical and surgical complications, as well as hospitalization time and activities of the patients (2, 14, 22, 31, 34, 35).

The reasons for delay to surgery are multifactorial. They can be patient related and/or systems related, which can be avoided. Patient related factors are mostly age related comorbidities. Surgical delay is only being warranted in the presence of medical conditions that contribute to mortality and are optimizable (3, 4, 11, 24, 32, 33).

Trying to standardize the treatment in our institution, we are using an in hospital hip fracture protocol when treating frail patients with these injury. The protocol was introduced in 2015 and it is based on NICE guidelines for hip fractures (8) and adapted regarding local infrastructure.

Main purpose of our protocol is to assure multidisciplinary approach throughout treatment of hip fracture patients in our hospital. The members of our team are beside trauma surgeons and trauma nurses: internal medicine consultant, anaesthesia attending, physiotherapist and psychologist. The protocol is started already in emergency department. If there is a need for additional examination and treatment, the patient is admitted to the

*Table 1. Demographic data of operated hip fractures during the study period*

| Factor | | total | ≤ 48 h | | | > 48 h | | |
|---|---|---|---|---|---|---|---|---|
| | | | total | TF | FNF | total | TF | FNF |
| Total, % (number) | | 100 % (641) | 56.3 % (361) | 71 % (255) | 29 % (106) | 43.7 % (280) | 23 % (65) | 77 % (215) |
| Time to surg. (hours) | median (IQR) | | 15 (25) | 12 (17) | 34 (31) | 95 (65) | 78 (56) | 103 (60) |
| Age (years) | median (IQR) | 82 (14) | 82 (16) | 82 (14) | 79 (24) | 82 (11) | 84 (8) | 82 (12) |
| | < 40 | 2 % | 3 % | 2 % | 5 % | 0 % | 0 | 0 |
| | 40–60 | 7 % | 10 % | 8 % | 16 % | 3 % | 2 % | 3 % |
| | 60–80 | 31 % | 30 % | 30 % | 30 % | 33 % | 15 % | 38 % |
| | >80 | 60 % | 57 % | 60 % | 49 % | 64 % | 83 % | 58 % |
| Gender | female | 69 % | 69 % | 74 % | 43 % | 69 % | 78 % | 67 % |
| | male | 31 % | 31 % | 26 % | 57 % | 31 % | 22 % | 33 % |
| Operation type | OS | 59 % | 84 % | 100 % | 44 % | 28 % | 100 % | 6 % |
| | HAP | 41 % | 16 % | 0 | 56 % | 72 % | 0 | 94 % |
| ASA grade | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 4 | 2 % | 3 % | 2 % | 3 % | 2 % | 3 % | 2 % |
| | 3 | 55 % | 44 % | 44 % | 44 % | 69 % | 85 % | 64 % |
| | 2 | 40 % | 48 % | 49 % | 46 % | 29 % | 12 % | 34 % |
| | 1 | 3 % | 5 % | 4 % | 7 % | 0 | 0 | 0 |
| ACT | Yes | 16 % | 5 % | 5 % | 5 % | 31 % | 66 % | 20 % |
| | No | 84 % | 95 %) | 95 % | 95 %) | 69 % | 34 % | 80 % |
| NRPT | Yes | 20 % | 13 % | 11 % | 17 % | 30 % | 17 % | 33 % |
| | No | 80 % | 87 % | 89 % | 83 % | 70 % | 83 % | 67 % |
| Residence | Home | 78 % | 78 % | 77 % | 81 % | 77 % | 73 % | 79 % |
| before | Nursing home | 20 % | 20 % | 21 % | 18 % | 20 % | 23 % | 19 % |
| injury | Other | 2 % | 2 % | 2 % | 1 % | 3 % | 5 % | 2 % |

TF – trochanteric fracture; FNF – femoral neck fracture; ≤ 48 – operated within 48 hours after admission; > 48 operated after 48 hours after admission; Time to surgery – the time from hospital admission to surgery; OS – osteosynthesis; HAP – hip arthroplasty; ASA American Society of Anaesthesiologists; ACT – anticoagulant therapy; NRPT – non-routine preoperative tests; IQR – interquartile range.

traumatology ward, where is seen by an internal medicine consultant. An exact time interval to surgery was not set in our protocol, but the goal is to operate these patients shortly after they are medically optimized.

The operation team for osteosynthesis (OS) includes the attending trauma surgeon and a resident. For arthroplasty (AP) operation team members are: an attending and two residents. All anaesthesia is done under the supervision of the senior anaesthetist. A day after the surgery patients start with physiotherapy. They are discharged from the hospital when they are able to do physiotherapy appropriate for their preinjury activity and health.

In the present study, we analysed the extent and reasons for surgical delay in hip fracture treatment in our institution and if delay impacts on mortality.

## MATERIAL AND METHODS

### Patients

We treated 693 patients with trochanteric (TF) and femoral neck fractures (FNF) in the period between January 1st, 2016 and December 31st, 2016. We have operated 663 (95.7%) patients. We included 641 patients in the study. We had to exclude 22 (3%) operated patients who were foreigners and were unreachable for follow up. There were no other exclusion criteria.

The reason for conservative treatment was general bad state in 19 patients (8 TF and 11 FNF) and impacted FNF in good position in 11 cases.

Clinical data were collected retrospectively from the hospital's database BIRPIS, including age, gender, American Society of Anaesthesiologists score (ASA), date and time of hospital admission, time of surgery (operations in first 48 hours were considered early), type of surgery (OS or AP), anticoagulant therapy (ACT), non-routine pre-operative tests (NRPT) (sonography of heart or abdomen, CT, etc.). OS was performed by screws, proximal femoral nail or dynamic hip screw and AP was partial or total hip prosthesis.

The time of death was obtained from the federal database at the National Institute of Health; the last date checked was June 1st, 2018.

The study was conducted in compliance with national legislation and approved by the National Medical Ethics Committee of Ministry of Health.

*Table 2. Multivariable logistic regressions show associations between independent variables and time to surgery (> 48 hours)*

| | TOTAL | | | TF | | | FNF | | |
|---|---|---|---|---|---|---|---|---|---|
| **Independ. variable** | **df** | **P value** | **OR [95% CI]** | **df** | **P value** | **OR [95% CI]** | **df** | **P value** | **OR [95% CI]** |
| Operation type | 1 | < 0.001 | 23.1 [14.6 – 37.8] | | NA | NA | 1 | 0.001 | 17.2 [7.8 – 41.6] |
| ACT | 1 | < 0.001 | 21.4 [11.1 – 43.1] | 1 | < 0.001 | 31.1 [14.3 – 73.3 ] | 1 | 0.001 | 6.9 [2.4 – 24.6] |
| NRPT | 1 | < 0.001 | 2.8 [1.6 – 5.1] | 1 | 0.62 | 1.31 [0.4 – 3.7] | 1 | < 0.001 | 4.0 [1.9 – 8.8] |
| Age | / | 0.23 | 1.0 [1.0 – 1.0] | / | 0.10 | 1.0 [0.9 – 1.0] | 3 | 0.38 | 1.0 [1.0 – 1.0] |
| Preinjury residence | 2 | 0.87 | 1.0 [0.6 – 1.5] | 2 | 0.39 | 0.7 [0.4 – 1.5] | 2 | 0.58 | 1.2 [0.6 – 2.1] |
| ASA grade | 3 | 0.53 | 0.9 [0.5 – 1.4] | 3 | 0.049 | 2.2 [1.0 – 4.9] | 3 | 0.66 | 1.2 [0.6 – 2.2] |

NA – not analysed; operation type – OS or AP; df – degrees of freedom; CI – confidence interval; OR – odds ratio; grey shadowed cells – statistically significant.

## Statistics

Statistical analysis was performed using Rstudio version 1.1.463. Categorical and nominal variables were modeled as factors and expressed as absolute numbers and percentages. Continues variables were presented as medians and interquartile ranges (IQR). Variables were analyzed with simple logistic regressions and multivariable logistic regressions. Survival analysis was achieved with Log-rank tests and Cox proportional-hazards model. For logistics regression odds ratios (OR) and 95% confidence intervals (CI) were calculated. While for Cox proportional hazards model hazard ratios (HR) and 95% CI were calculated. P-values < 0.05 were considered statistically significant.

## RESULTS

## Timing

The study analysed 641 patients with operated hip fractures. They were separated into two groups based on time to surgery that was either in the first 48 hours or later. The examined variables were: age, gender, ASA, ACT, NRPT, preinjury residence (home or nursing home), type of surgery (OS or AP) and time till surgery. Demographic data are presented in Table 1.

56.3% patients were operated in the first 48 hours. We found statistical significant differences between the groups in all variables except for preinjury residence. Median age was 82 years in both groups (but the average age was significant higher in late group; p = 0.017), less patients had ASA above 2 (47% vs. 71%; p < 0.001), had to take ACT (5% vs. 31%; p < 0.001) and needed NRPT (13% vs 30%; p < 0.001) in the early group. We also performed significantly less AP for FNF (56% vs 94%; p < 0.001) early.

We analysed the same variables to find the difference between TF and FNF in each time group. We found statistical significant differences in time to surgery and age in both time frames. Median time to surgery was shorter in TF: 12 hours for TF vs. 34 hours for FNF (p < 0.001) in the early group and 78 hours for TF and 103 hours for FNF (p = 0.02) in the late. TF patients were older (2 years in early; p = 0.034 and 3 years in late group; p = 0.001).

In the late group we found statistical significant differences also in ACT and ASA. More TF patients were on ACT than FNF (66% TF vs. 20% FNF; p < 0.001) and also ASA above 2 was higher (88% TF vs. 66% FNF; p = 0.001). All other differences between TF and FNF were not significant in either time frame.

Multivariable logistic regression presented in Table 2 predicted that for both fracture types operation type (AP) (OR 23.1), ACT (OR 21.4) and NRPT (OR 2.8) had a significantly higher chance of receiving surgery after 48 hours (p < 0.001). The same goes for FNF patients (OR 17.2; p = 0.001). TF patients on the other hand have higher odds of being operated after 48 hours if needed ACT (OR 31.1; p < 0.001) or had higher ASA (OR 2.2; p = 0.049).

*Table 3. Thirty-day and 1-year mortality divided by type of fracture and time to surgery (≤ 48 / > 48 hours). The Log-rank test was used for assessing statistical significance between groups*

| **mortality** | **Fr. type** | **≤ 48 hours** (95% CI) | **P value** | **> 48 hours** (95% CI) | **P value** | **P value** |
|---|---|---|---|---|---|---|
| **30 days** | all | 4.4 % (2.2–6.5) | | 6.1 % (3.2–8.8) | | 0.4 ↔ |
| | TF | 5.1 % (2.4–7.8) | 0.3 ↕ | 13.9 % (5.0–21.9) | 0.002 ↕ | 0.006 ↔ |
| | FNF | 2.8 % (0–5.9) | | 3.7 % (1.2–6.2) | | 0.6 ↔ |
| **1 year** | all | 17.2 % (13.2–21.0) | | 20 % (15.2–24.5) | | 0.4 ↔ |
| | TF | 18.8 % (13.9–23.5) | 0.2 ↕ | 32.3 % (19.9–42.8) | 0.003 ↕ | 0.01 ↔ |
| | FNF | 13.2 % (6.5–19.4) | | 16.3 % (11.2–21.1) | | 0.4 ↔ |

95% CI – 95% confidence interval; ↕ – vertical difference between values; ↔ – horizontal difference between values; grey shadowed cells – statistically significant.

*Table 4. Multivariable survival analyses of independent variables with Cox proportional-hazards regression*

| | TOTAL | | | TF | | | FNF | | |
|---|---|---|---|---|---|---|---|---|---|
| **Independent variable** | **df** | **P value** | **HR [95% CI]** | **df** | **P value** | **HR [95% CI]** | **df** | **P value** | **HR [95% CI]** |
| **ASA grade** | 3 | < 0.001 | 1.9 [1.4–2.7] | 3 | 0.008 | 1.8 [1.2 – 2.7] | 3 | 0.001 | 2.3 [1.4–3.9] |
| **Preinjury residence** | 2 | 0.012 | 1.4 [1.1–1.9] | 2 | 0.27 | 1.3 [0.8 – 1.8] | 2 | 0.01 | 1.7 [1.1–2.5] |
| **Age** | / | < 0.001 | 1.1 [1.0–1.1] | / | < 0.001 | 1.1 [1.0 – 1.1] | / | 0.003 | 1.0 [1.0–1.1] |
| **Time to surgery ≤ 48h** | 1 | 0.77 | 1.1 [0.7–1.5] | 1 | 0.57 | 0.9 [0.5 – 1.5] | 1 | 0.87 | 1.0 [0.6–1.6] |
| **Operation type** | 1 | 0.93 | 1.0 [0.7–1.4] | NA | NA | NA | NA | NA | NA |
| **ACT** | 1 | 0.78 | 1.0 [0.6–1.4] | 1 | 0.72 | 1.1 [0.6 – 2.1] | 1 | 0.95 | 1.0 [0.6–1.8] |
| **NRPT** | 1 | 0.47 | 0.9 [0.6–1.2] | 1 | 0.76 | 1.1 [0.6 – 2.0] | 1 | 0.20 | 0.7 [0.5–1.2] |

NA – not analyzed; df – degrees of freedom; HR – hazard ratio; CI – confidence interval; gray shadowed cells –statistical significant.

## Mortality

The 30-day mortality in patients operated early was 4.4%, if late 6.1% (p = 0.4). TF patients operated early had significantly lower 30-day mortality compared to late group (5.1% vs. 13.9%; p = 0.006). This difference was not significant in FNF patients (2.8% vs. 3.1%; p = 0.6).

One-year mortality in patients operated early was 17.2% and if late 20% (p = 0.4). TF patients operated early had significantly lower 1-year mortality compared to late group (18.8% vs. 32.3%; p = 0.01). This difference was again not significant in FNF patients (13.2% vs. 16.3%; p = 0.4). There was also a statistically significant difference between TF and FNF patients operated late, both for 30-day mortality (p = 0.002) and 1-year mortality (p = 0.003).

Data presented in Table 3.

Multivariable logistic regression presented in Table 4 predicted that patients with higher ASA (hazard ratio (HR) 1.9), living in a nursing home (HR 1.4; p < 0.001) and higher age (HR 1.1; p = 0.012) had a significantly higher risk of mortality. TF patients with higher ASA (HR 1.8; p = 0.008) and higher age (HR 1.1; p < 0.001) had a significant higher risk of mortality. On the other hand, FNF patients with higher ASA (OR 2.3; p = 0.001) and living in a nursing home (OR 1.7; p = 0.01) were predicted to have a significantly higher mortality. All other variables were not significant.

## DISCUSSION

In 2016 (study period) 4095 patients with fractures were operatively treated in our institution. The low proportion of hip fractures (16.5%) is connected with the level of care provided in our center and it can be problematic, because the importance of this fractures can easily be underestimated.

## Time to surgery

We operated 56.3% of patients with hip fractures in the first 48 hours after admission. Studies dealing with the timing of surgery for hip fractures show large variation (from 40% to 90%) in the proportion of patients treated in the proposed time intervals and some have shown great improvement in the timing for hip surgeries after the implementation of guidelines (3, 8, 9, 11, 12, 27, 41). The patient characteristics in our study did not differ from studies that showed higher adherence to earlier hip operation (17, 28).

We were able to show statistical differences in age and ASA between the patients operated early and late, but except for ASA in TF, they didn't contribute to delay. Higher ASA need medical optimization, which has a positive effect on outcome (20). Many elderly patients had poorly treated chronic diseases and their physiological reserve was enough for daily activities, but injury causes an adverse physiological reaction. This patient related delay can be considered to be "positive". True delay starts when patients are prepared for surgery, but they are not operated.

Late operation was mainly due to ACT, NRPT and operation type. These factors can be called treatment related rather than patient related.

In both fracture groups, we found ACT to be an important factor. Warfarin was taken by 75% of our patients on ACT. According to our hip fracture protocol the accepted value of INR is not higher than 1.3. We start K vitamin therapy already in emergency department. All patients receive low dose heparin (LOH). The last dose of LOH is administered 12 hours before the surgery (38). Majority of our patients are operated under subarachnoid block anaesthesia. Indications for general anaesthesia in our hip fracture patients are: severe aortic stenosis, severe confusion which cannot be suppressed by medications or technical problems (27, 30). Studies have shown that vitamin K application will lower INR to an acceptable level in 24 to 36 hours in 90% of patients (1, 19, 42). Because we start K-vitamin therapy in the emergency department, the majority of ACT patients are prepared for surgery sooner than in 48 hours, so further delay is not ACT related.

NRPT is also an important reason for delay in the FNF group. The majority of non-routine tests were heart sonographies (HS) in FNF patients. The predicted blood loss in hip arthroplasty can be in elderly patients a significant risk because of poor heart function. HS provides some additional information and is beneficial if we change the general treatment from operative to conservative because of new data (severe heart decompensation) or if change the anaesthesia type (from subarachnoid block to general) in case of severe aortic stenosis (27, 30). The most important problem regarding NRPT in our institution is that in some cases we have to wait for the test to happen to long and in this way we generate delays and in great majority of cases it does not change the treatment.

We were able to show that the most important reason for late operation was the type of the operation. Patients who were operated with AP were less likely to be operated in first 48 hours after admission. The type of operation is strongly connected to type of fracture. We thus also found a disproportion of TF and FNF patients operated early. These differences may be patient factor related or procedure related. Comparing TF and FNF patients operated in the first 48 hours we found no significant differences in the patient characteristics. On the other hand, in the group of patients operated after 48 hours, FNF patients were younger, with lower ASA and fewer patients needed ACT. We can therefore conclude that FNF patients operated late had fewer medical reasons for delay than TF patients.

The majority of TF patients without any contraindication for early surgery are in our institution listed for surgery on the same day and most of them will be operated in afterhours. Studies have shown that hip fracture operations in afterhours do not have worse results or more complications than normal-hour surgery (5, 28). We have one complete operative time dedicated for fracture operations in the hospital in the afternoon and night, so cases have to be prioritized. For TF patients that cannot be operated the same day, surgery will be planned for the following afternoon, because the morning trauma schedule is already booked.

In contrast to patients with TF, FNF patients are rarely put on the afterhours list. The main reason is the difference in operation logistics between OS and AP. The general indication for AP in FNF in our setting is patients' age more than 65 years with at least Garden type 2. In some cases we decide for AP also in younger patients (severe unreducible dislocation of the fracture, chronic conditions which influences the rehabilitation). We do OS in FNF patients over 65 years in Garden type 1 and if they are fit and lucid. Arthroplasty operations are more time and human resource consuming. The operation time for AP is almost twice as long as that for OS (6, 26) and, in our protocol; the operative team for AP is three surgeons. The senior surgeon has to be experienced in hip prosthetics. We rarely have enough time and (competent) human recourses to operate them in afterhours. We normally assign these patients to the first available place on the morning trauma list, again doing prioritization.

The lack of operative capacities and teams are the reasons for a large proportion of delays to operative treatment in our institution. Even when patients are optimized, they cannot sometimes be treated shortly after, because also other fracture patients have to be operated and prioritization have to be done. The same problem has also been described in other big level 1 trauma centres (21, 36).

### Mortality

Overall 30-day mortality was 5.1% and 1-year 18.4%. The results in other studies showed 30-day mortality of 5%–10% and one-year mortality of 15%–30% (3, 9, 12, 20, 23). The important factors influencing the mortality in our study are patient related (ASA, age and preinjury residence), but not surgery delay. The studies which reported differences due to timing were done on much higher numbers of patients (9, 13, 18, 25, 39). The reason for lower 30-day and 1-year mortality in patients with FNF compared to the TF group if operated later is in younger FNF patients with less comorbidity. This difference has already been described in other studies (15, 40).

In much smaller group of our patients who were treated conservatively (30 patients) the 30-day mortality was 15.4% and 1-year 47.2%. In conservatively treated group 19 patients were not operated because of generally bad health, all others were patients with Garden 1 FNF who were able to walk with crutches without severe pain. The only statistically significant difference between operated and conservatively treated patients in our series was ASA (operated patients ASA > 2; 57% vs. not operated ASA > 2; 82%) (16). It is very difficult from this date to conclude that the difference in mortality was due to ASA difference only. So the conservative treatment has to be reserved only for patients with great risk of perioperative death.

We see the reasons for low mortality in our series in our multidisciplinary approach and experienced team performing the surgery (attending surgeon always present, every operation nurse is trained in orthopaedic trauma and all anaesthesia is done under the supervision of the attending anaesthetist). The same reasons for good results were found by other authors (7). We also take great care in pain treatment and patients start respiratory and locomotor physiotherapy even before surgery and are continued immediately after the operation. Patients are not discharged from our department before they are medically stable and able to cooperate fully in physiotherapy.

Our study has some limitations. The main one is its retrospectivity, because we had to limit our research to patient characteristics that are documented in all patient files. We were unable to study the influence of specific patients' illnesses and medical or surgical complications, because we were not sure that all illnesses and complications were documented with every patient. The second limitation is the relatively low number of patients.

## CONCLUSIONS

We recommend a short interval between admission and operation, although we believe that, for a good outcome, the quality of surgery and a multidisciplinary approach are at least as important as the timing. We did not find delay to surgery to be a factor influencing mortality rates, but unnecessarily long delay in frail patients at the least causes unnecessary pain and immobility. Because of growing numbers of elderly patients with proximal femur fractures, the implementation of protocols must be accompanied by increased operating theatre capacities; otherwise it is impossible to operate patients immediately after they are prepared for surgery. In level 1 trauma centres, these theatres should be separated from those for other severe injuries to avoid unfair prioritizing of the patients.

***Acknowledgements*** *The authors thank Martin Cregeen for language editing the paper.*

### References

1. Ahmed I, Khan MA, Nayak V, Mohsen A. An evidence-based warfarin management protocol reduces surgical delay in hip fracture patients. J Orthop Traumatol. 2014;15:21–27.
2. Al-Ani AN, Samuelsson B, Tidermark J, Norling A. Early operation on patients with a hip fracture improved the ability to return to independent living. A prospective study of 850 patients. J Bone Joint Surg Am. 2008;90:1436–1442.
3. Aqil A, Hossain F, Sheikh H, Aderinto J, Whitwell G, Kapoor H. Achieving hip fracture surgery within 36 hours: an investigation of risk factors to surgical delay and recommendations for practice. J Orthop Traumatol. 2016;17:207–213.
4. Bhandari M, Swiontkowski M. Management of acute hip fracture. N Engl J Med. 2017;377:2053–2062.
5. Bosma E, de Jongh MA, Verhofstad MH. Operative treatment of patients with pertrochanteric femoral fractures outside working hours is not associated with a higher incidence of complications or higher mortality. J Bone Joint Surg Br. 2010;92:110–115.
6. Cicek H, Seyfettinoglu F, Kilicarslan K, Ogur HU, Öztürk L, İnkaya E. What should be the preferred choice of hemiarthroplasty technique in American Society of Anesthesiologists (ASA) class III patients with femoral neck fractures? Cemented or cementless. Injury. 2015;46:1567–1570.
7. Dokládalová P, Majerníček M, Vaculík J, Kubeš R, Schwarz O, Dungl P. [Results of surgically treated patients for hip fracture – complications, mortality]. Acta Chir Orthop Traumatol Cech. 2017;84:424–430.
8. Ftouh S, Morga A, Swift C; Guideline Development Group. Management of hip fracture in adults: summary of NICE guidance. BMJ. 2011;342:d3304.
9. Guy P, Sheehan KJ, Morin SN, Waddell J, Dunbar M, Harvey E, Sirett S, Sobolev B, Kuramoto L, Tang M; Canadian Collaborative Study on Hip Fractures. Feasibility of using administrative data for identifying medical reasons to delay hip fracture surgery: a Canadian database study. BMJ Open. 2017;7:e017869.
10. Heyes GJ, Tucker A, Marley D, Foster A. Predictors for 1-year mortality following hip fracture: a retrospective review of 465 consecutive patients. Eur J Trauma Emerg Surg. 2017;43:113–119.
11. Holt G, Smith R, Duncan K, McKeown DW. Does delay to theatre for medical reasons affect the peri-operative mortality in patients with a fracture of the hip? J Bone Joint Surg Br. 2010;92:835–841.
12. Khan SK, Jameson SS, Avery PJ, Gray AC, Deehan DJ Does the timing of presentation of neck of femur fractures affect the outcome of surgical intervention. Eur J Emerg Med. 2013;20:178–181.
13. Klestil T, Röder C, Stotter C, Winkler B, Nehrer S, Lutz M, Klerings I, Wagner G, Gartlehner G, Nussbaumer-Streit B. Impact of timing of surgery in elderly hip fracture patients: a systematic review and meta-analysis. Sci Rep. 2018;8:13933.
14. Kopp L, Edelmann K, Obruba P, Procházka B, Blšťáková K, Džupa V. [Mortality risk factors in the elderly with proximal femoral fracture treated surgically]. Acta Chir Orthop Traumatol Cech. 2009;76:41–46.
15. Koval KJ, Aharonoff GB, Rokito AS, Lyon T, Zuckerman JD. Patients with femoral neck and intertrochanteric fractures. Are they the same? Clin Orthop Relat Res. 1996;330:166–172.
16. Kristan A, Omahen S, Puketa V, Benulic C, Zorman M, Cimerman M. [Analysis of surgically treated patients with hip fracture admitted to the Department of Traumatology, UMC Ljubljana in 2016]. Zdrav Vestn. 2020;89:268–277.
17. Kusen J, van der Vet P, Wijdicks FJ, Houwert M, Dijkgraaf M, Hamaker M, Geraghty O, Verleisdonk EJ, van der Velde D. Different approaches towards geriatric trauma care for hip fracture patients: an inter-hospital comparison. Eur J Trauma Emerg Surg. 2019;Apr. 24.
18. Leer-Salvesen S, Engesæter LB, Dybvik E2, Furnes O, Kristensen TB, Gjertsen JE. Does time from fracture to surgery affect mortality and intraoperative medical complications for hip fracture patients? An observational study of 73 557 patients reported to the Norwegian Hip Fracture Register. Bone Joint J. 2019;101-B:1129–1137.
19. Leonidou A, Rallan R, Cox N, Pagkalos J, Luscombe J. Comparison of different warfarin reversal protocols on surgical delay and complication rate in hip fracture patients. J Orthop Surg. (Hong Kong). 2013;21:142–145.
20. Lewis PM, Waddell JP. When is the ideal time to operate on a patient with a fracture of the hip?: a review of the available literature. Bone Joint J. 2016;98-B:1573–1581.
21. Metcalfe D, Olufajo OA, Zogg CK, Gates JD, Weaver MJ, Harris MB, Rios-Diaz AJ, Haider AH, Salim A. Are older adults with hip fractures disadvantaged in level 1 trauma centers? Med Care. 2016;54:616–622.
22. Mitchell SM, Chung AS, Walker JB, Hustedt JW, Russell GV, Jones CB. Delay in hip fracture surgery prolongs postoperative hospital length of stay but does not adversely affect outcomes at 30 days. J Orthop Trauma. 2018;32:629–633.
23. Novotný P, Dědek T, Frank M, Smejkal K, Bútora S, Kočí J, Trlica J. [Extracapsular proximal femoral fractures - retrospective evaluation of a group of patients with a focus on complications of treatment]. Acta Chir Orthop Traumatol Cech. 2018;85:249–253.
24. Orosz GM, Hannan EL, Magaziner J, Koval K, Gilbert M, Aufses A, Straus E, Vespe E, Siu AL. Hip fracture in the older patient: reasons for delay in hospitalization and timing of surgical repair. J Am Geriatr Soc. 2002;50:1336–1340.
25. Orosz GM, Magaziner J, Hannan EL, Morrison RS, Koval K, Gilbert M, McLaughlin M, Halm EA, Wang JJ, Litke A, Silberzweig SB, Siu AL. Association of timing of surgery for hip fracture and patient outcomes. JAMA. 2004;291:1738–1743.
26. Parker MJ. Sliding hip screw versus intramedullary nail for trochanteric hip fractures; a randomised trial of 1000 patients with presentation of results related to fracture stability. Injury. 2017;48:2762–2767.
27. Parker MJ, Handoll HH, Griffiths R.Anaesthesia for hip fracture surgery in adults.CochraneDatabase Syst Rev. 2004;4:CD000521.
28. Pincus D, Desai SJ, Wasserstein D, Ravi B, Paterson JM, Henry P, Kreder HJ, Jenkinson R. Outcomes of after-hours hip fracture surgery. J Bone Joint Surg Am. 2017;99:914–922.
29. Pincus D, Ravi B, Wasserstein D, Huang A, Paterson JM, Nathens AB, Kreder HJ, Jenkinson RJ, Wodchis WP. Association between wait time and 30-day mortality in adults undergoing hip fracture surgery. JAMA. 2017;318:1994–2003.
30. Rodgers A, Walker N, Schug S, McKee A, Kehlet H, van Zundert A, Sage D, Futter M, Saville G, Clark T, MacMahon S. Reduction of postoperative mortality and morbidity with epidural or spinal anaesthesia: results from overview of randomised trials. BMJ. 2000;321:1493.
31. Sermon A, Rochus I, Smeets B, Metsemakers WJ, Misselyn D, Nijs S, Hoekstra H. The implementation of a clinical pathway enhancing early surgery for geriatric hip fractures: how to maintain a success story? Eur J Trauma Emerg Surg. 2019;45:199–205.
32. Sheehan KJ, Sobolev B, Guy P. Mortality by timing of hip fracture surgery: factors and relationships at play. J Bone Joint Surg Am. 2017;99:e106.
33. Sheehan KJ, Sobolev B, Villán Villán YF, Guy P. Patient and system factors of time to surgery after hip fracture: a scoping review. BMJ Open. 2017;7:e016939.
34. Siegmeth AW, Gurusamy K, Parker MJ. Delay to surgery prolongs hospital stay in patients with fractures of the proximal femur. J Bone Joint Surg Br. 2005;87:1123–1126.

35. Simunovic N, Devereaux PJ, Sprague S, Guyatt GH, Schemitsch E, Debeer J, Bhandari M. Effect of early surgery after hip fracture on mortality and complications: systematic review and meta-analysis. CMAJ. 2010;182:1609–1616.
36. Sirois MJ, Côté M, Pelet S. The burden of hospitalized hip fractures: patterns of admissions in a level I trauma center over 20 years. J Trauma. 2009;66:1402–1410.
37. Sobolev B, Guy P, Sheehan KJ, Kuramoto L, Bohm E, Beaupre L, Sutherland JM, Dunbar M, Griesdale D, Morin SN, Harvey E; Canadian Collaborative Study on Hip. Time trends in hospital stay after hip fracture in Canada, 2004–2012: database study. Arch Osteoporos. 2016;11:13.
38. Sostaric M, Mavri A, Vene N, Poredos P, N Kodric. [Guidelines for tromboprofilactic treatment in regional anaesthesia]. Zdrav Vestn. 2009;78:619–625.
39. Suhm N, Kaelin R, Studer P, Wang Q, Kressig RW, Rikli D, Jakob M, Pretto M. Orthogeriatric care pathway: a prospective survey of impact on length of stay, mortality and institutionalisation. Arch Orthop Trauma Surg. 2014;134:1261–1269.
40. Tseng FJ, Chia WT, Pan RY, Lin LC, Shen HC, Wang CH, Shyu JF, Weng CF. Comparison of arthroplasty vs. osteosynthesis for displaced femoral neck fractures: a meta-analysis. J Orthop Surg Res. 2017;12:131.
41. Ventura C, Trombetti S, Pioli G, Belotti LM, De Palma R. Impact of multidisciplinary hip fracture program on timing of surgery in elderly patients. Osteoporos Int. 2014;25:2591–2597.
42. Yassa R, Khalfaoui MY, Hujazi I, Sevenoaks H, Dunkow P. Management of anticoagulation in hip fractures: a pragmatic approach. EFORT open reviews. 2017;2:394–402.

**Corresponding author:**
Anže Kristan, MD
Division of Surgery, Department of Traumatology
University Medical Centre Ljubljana
Zaloška cesta 2
Ljubljana, Slovenia
E-mail: anze.kristan@kclj.si