

Association of cognitive status with mobility and functioning after femoral neck fracture surgery in elderly patients: differences between hemiarthroplasty and internal fixation

Povezanost kognitivnega stanja z gibljivostjo in funkcijskim stanjem po operacijskem zdravljenju zloma vratu stegenice pri starejših poškodovancih: razlike med uporabo delne cementne endoproteze in notranje fiksacije

Nataša Kos,¹ Helena Burger,^{2,3} Gaj Vidmar^{2,4}

¹ University Medical Centre, Ljubljana, Slovenia

² University Rehabilitation Institute, Republic of Slovenia, Ljubljana, Slovenia

³ University of Ljubljana, Faculty of Medicine, Department of Physical and Rehabilitation Medicine, Ljubljana, Slovenia

⁴ University of Ljubljana, Faculty of Medicine, Institute for Biostatistics and Medical Informatics, Ljubljana, Slovenia

Korespondenca/ Correspondence:

assist. prof. Gaj Vidmar, PhD, University Rehabilitation Institute, Republic of Slovenia, Linhartova 51, SI-1000 Ljubljana, Slovenia
tel: +386 1 4758440, gaj.vidmar@ir-rs.si

Glavne besede:

zlom kolka, operacijski posegi, sposobnost hoje, dnevne dejavnosti, spoznavni procesi

Izvodilo

Izhodišče: Primerjava izida med dvema načina operacijskega zdravljenja zloma vratu stegenice – cementno delno endoprotezo (CDE) in notranjo fiksacijo (NF) – ostaja odprto vprašanje. Opravili smo nove analize podatkov iz že objavljene študije, da bi preverili vpliv kognitivnih motenj na gibljivost in funkcijsko stanje po tovrstni operaciji ter ga primerjali med skupinama, zdravljenima s CDE in NF.

Metode: V nerandomizirano prospektivno študijo je bilo vključenih 66 starejših poškodovancev. Skupini (CDE in NF, v vsaki je bilo 33 poškodovancev) sta bili uravnoteženi glede starosti, spola in dejavnosti pred poškodbo. Zbrali smo ocene sposobnosti hoje (opisne, s prehojeno razdaljo in z indeksom sposobnosti za hojo – WAI), kognitivnega stanja (s kratkim preizkusom spoznavnih sposobnosti – KPSS) in samostojnosti pri opravljanju dnevnih dejavnosti (opisne in z lestvico funkcijske neodvisnosti – FIM).

Rezultati: Povezanost z dosežkom na KPSS ob odpustu je bila v skupini, zdravljeni z NF, višja kot v skupini, zdravljeni s CDE, za vsa obravnavana merila izida: prehojeno razdaljo ob odpustu, zmožnost samostojne hoje (s pripomočki) ob odpustu, zmožnost hoje zunaj tri mesece po odpustu, stopnjo samostojnosti pri dnevnih dejavnostih tri mesece po odpustu, izboljšanje na motorični podlestvici FIM tri mesece po odpustu in oceno z WAI ob odpustu.

Zaključki: Prisotnost kognitivnih motenj negativno vpliva na zmožnost hoje in funkcijsko sta-

nje predvsem pri poškodovancih po zlomu vratu stegenice, operacijsko zdravljenih z NF, pri poškodovancih, zdravljenih s CDE, pa ne oziroma znatno manj. To je smiselno upoštevati pri odločanju o vrsti kirurškega posega.

Abstract

Background: Comparison of outcomes between two different operative treatments of femoral neck fracture – hemiarthroplasty (HA) and internal fixation (IF) – remains an open issue. We performed new analyses of data from a previously published study with the aim of investigating the influence of cognitive problems on mobility and functioning after such surgery and comparing it between groups treated with HA and IF.

Methods: Sixty-six elderly patients were consecutively enrolled in a prospective non-randomised study. The two groups (HA and IF, each comprising 33 patients) were balanced regarding age, gender and activity before injury. Data were gathered on their walking ability (categorised, measured via walking distance, and assessed using Walking Ability Index – WAI), cognitive status (assessed using Mini Mental State Examination – MMSE) and independence in activities of daily living (categorised, and assessed using Functional Independence Measure – FIM).

Results: The association with MMSE score on admission was higher in the IF group than in the HA group for all the analysed outcome measures, i.e., walking distance at discharge, ability to walk unassisted (with walking aids) at discharge, ability to walk outdoors after three months, inde-

Key words:

hip fracture, surgical procedures, walking ability, activities of daily living, cognitive processes

Citirajte kot/Cite as:

Zdrav Vestn 2013;
82: 150–7

Prispelo: 21. jan. 2012,
Sprejeto: 3. dec. 2012

pendence in activities of daily living after three months, improvement in motor FIM subscore after three months and WAI score at discharge.

Conclusions: Presence of cognitive problems adversely affects walking ability and functioning

mainly in patients operatively treated with IF after femoral neck fracture, and not (or to a much lesser extent) in patients treated with HA. It is recommended to take this into account during surgical decision-making.

Introduction

Hip fractures are the second leading cause of hospitalisation in the geriatric population.¹ The most common type of hip fracture in the elderly is fracture of the femoral neck.^{1,2} The incidence varies with age. As people live longer, it is possible that the total number of hip fractures in the world, estimated at 1.7 million in 1990, will continue rising exponentially until reaching 6.3 million by the year 2050.^{3,4} Over 90 % of hip fractures are associated with falls and the risk of falling is elevated by the presence of one or more cognitive impairments.^{5,6}

The treatment of femoral neck fracture is operative. The most important goal of operative treatment of femoral neck fracture is to restore function and to relieve pain. Primary arthroplasty and internal fixation are the two main options. Even though several randomised studies have been conducted, the optimal treatment in the elderly is still a subject of controversy.⁷ There is no unified opinion on the optimal doctrine of treating such fractures in our country, either.^{8,9}

Cognitive status is likely a factor to be considered in choosing the type of repair. But only a few studies have compared outcomes after using internal fixation and hemiarthroplasty in cognitively impaired elderly with hip fracture. Internal fixation is generally recommended, because mortality after a major operation like hemiarthroplasty is high.¹⁰ On the other hand, the patients operated using internal fixation were found to have more post-surgery complications and reoperations.¹¹ Furthermore, a recent study indicated that short-term mobility and functional outcome tend to be more favourable after hemiarthroplasty.¹²

Behavioural and cognitive impairments undoubtedly affect the person's ability to participate effectively in rehabilitation. Elderly persons with cognitive impairments

are therefore not likely to recover to full pre-hip-fracture function, which is the goal of their rehabilitation. Hence, the purpose of this study was to compare walking ability and functional outcome of elderly patients with femoral neck fracture treated with either internal fixation or hemiarthroplasty in relation to mental status.

Methods

Sixty-six elderly patients were included in a two-group prospective no-randomised trial. The inclusion criteria were age 65 years or more, femoral neck fracture due to fall, and the ability to walk before fracture. The exclusion criteria were neurological disease, associated fractures or polytrauma, and hip arthrosis. All the patients included in the study ($N=66$) were treated operatively. The surgeons were not aware of our study and chose the method of operation according to their own judgement. Two equal-sized groups of patients ($n=33$ each) were consecutively recruited within each operative method (the sample size considerations are reported in the preceding study¹²). All the eligible patients were identified at the time of hospital admission and prospectively followed up, whereby recruitment stopped in a group when 33 patients were reached. After the hemiarthroplasty group had been filled up, eight further patients undergoing hemiarthroplasty were skipped until the internal fixation group was also completed.

The patients were encouraged to pursue active rehabilitation, i.e., early mobilisation with physical therapy and occupational therapy. Specific physical therapy addressed a range of motion, transfer training, bed mobility and walking. The patients ambulated with a walking aid and with assistance from a therapist.

Demographic characteristic (age, gender) and information on pre-fracture living

conditions, function, ambulatory ability (including use of walking aids, walking outdoor/indoor and ability to walk up/down the stairs) and preoperative ability to perform activities of daily living were obtained at the time of admission through interviews with patients or their family members. Patient's cognition was assessed in the hospital during the first two days after surgery (henceforth referred to as *at admission* for brevity and easier reading in conjunction with the preceding study) and at discharge using the Mini Mental State Examination (MMSE). MMSE is scored from 0 to 30, with scores of less than 23 being indicative of moderate impairment, and scores of 24 or better being indicative of normal cognitive functioning.^{13,14} Walking ability was evaluated at discharge and after three months as walking without walking aid or with walking aid (canes, crutches or frame). At discharge, the walking distance in meters was also measured. At the three-month follow up, the ability to walk outdoor/indoor and to walk up/down the stairs was evaluated. Functional status was assessed at discharge and three months afterwards using the Functional Independence Measure (FIM). The FIM is a well-established and widely used measurement instrument in the field of rehabilitation internationally as well as in our country^{15,16} that includes 18 items covering independence in self-care, sphincter control, mobility, locomotion, communication, social interaction, problem solving and memory. A 7-point rating scale ranging from total dependence to complete independence with the total scores ranging between 18 and 126 is used; the FIM can be used as the aggregate score of the two subscales for motor function and cognitive function, but for evaluating functional activity one can use the motor subscale alone.¹⁷ The ability to perform activities of daily living was evaluated at discharge and three months after discharge. The assessment schedule and the methods used are reported in further detail and summarised in tabular form in the preceding publication.¹²

Averages of quantitative variables were compared between two groups using either independent samples *t*-test or exact Mann-

Whitney test (EMWT; depending on the feasibility of the assumptions of the former judged on substantial grounds and using normal probability plots). Associations involving ordinal variables were assessed using Spearman's rank-correlation coefficient (ρ). Correlations between numeric variables were assessed using Pearson's coefficient (r). Between-group difference in association between two numeric variables was tested using Chow-type test for regression slopes, i.e., entering a binary predictor (representing the group) and an interaction term (of the numeric and the binary predictor) in addition to the numeric predictor into the linear regression model and applying *F*-tests for nested models.¹⁸ Proportions were compared either using Fisher's exact test (between groups) or exact McNemar test (within group). Analyses were performed with SPSS for Windows 15.0.1 (SPSS Inc., Chicago, IL, 2006) software.

Results

Excellent comparability of the two groups in terms of demographic characteristics (mean age about 81 years, mostly women), concomitant diseases (cardiovascular disease in one third, diabetes in about one sixth of the patients) and pre-fracture functional status (nearly all patients able to walk up and down the stairs and perform activities of daily living independently) was already reported.¹² In addition, cognitive status, as assessed by the MMSE, did not differ between the groups immediately after surgery (hemiarthroplasty group: mean 21.3, SD 7.2; internal fixation group: mean 21.0, SD 7.4; $p=0.841$ from EMWT).

Below, previously reported and newly obtained results are reported in an alternating sequence. For each outcome measure addressed, i.e., within each paragraph, the results obtained in the preceding study (i.e., pertaining to comparison of the distribution of the variable in question between the two patient groups) are summarised first, followed by the newly added between-group comparison of association between cognitive status (as measured by MMSE) and the variable in question.

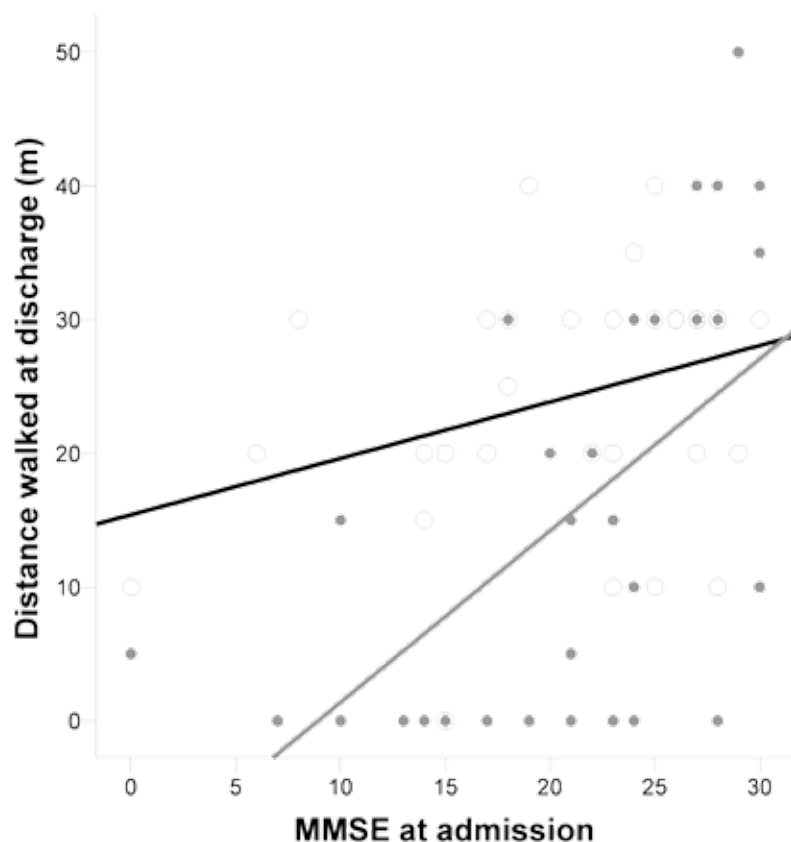


Figure 1: Association between MMSE at admission and distance walked at discharge by group (hemiarthroplasty group: black empty circles, black regression line; internal fixation group: grey filled circles, grey regression line).

As reported previously,¹² walking distance at discharge was longer in the hemiarthroplasty group (mean 24.4 m, SD 9.2 m) than in the internal fixation group (mean 15.5 m, SD 16.3 m; $p < 0.001$ from EMWT). The additional finding of the present analysis is that the correlation between MMSE at admission and walking distance at discharge was higher and clearly statistically significant in the group treated with internal fixation ($r = 0.583$; $p < 0.001$), whereas in the group treated with hemiarthroplasty it was lower and only marginally statistically significant ($r = 0.329$; $p = 0.062$) (Figure 1). Chow-type test confirmed that the slope obtained when regressing walking distance at discharge on MMSE was statistically significantly higher in the group treated with internal fixation than in the group treated with hemiarthroplasty (Figure 1; $p = 0.031$).

As also reported previously,¹² there were more patients in the hemiarthroplasty group capable of walking unassisted (i.e., either without a walking aid, with a crutch, with two crutches, or with a frame) at discharge compared to the internal fixation group (39 % vs. 12 %; $p = 0.022$ for the difference

in proportions between groups), and after three months mobility in both groups significantly improved in comparison with discharge (the proportion of patients capable of walking unassisted increased to 75 % and 50 % in the hemiarthroplasty and the internal fixation group, respectively; $p < 0.001$ for change within each group). Likewise with the walking distance, the present analysis found that the association between MMSE at admission and ambulation ability at discharge (coded as an ordinal variable, ranging from 1=unable-to-move-about to 8=able-to-walk-without-aids) was higher in the internal fixation group ($Rho = 0.669$, $p < 0.001$) than in the hemiarthroplasty group ($Rho = 0.568$, $p = 0.001$).

Another clinically important aspect of mobility after femoral neck fracture surgery is the ability to walk outdoors. It was previously reported¹² that 12 (38 %) patients treated with hemiarthroplasty and only 7 (25 %) patients treated with internal fixation were able to walk outdoors at three-month follow-up ($p = 0.051$ for the difference in proportion). Again, we have now found that the association of the ability to walk outdoors at three-month follow-up (coded as an ordinal variable: 1=unable-to-move-about, 2=able-to-move-around-in-apartment, 3=able-to-walk-outdoors) with MMSE at discharge was much higher and only statistically significant in the internal fixation group ($Rho = 0.585$, $p = 0.001$) as compared to the hemiarthroplasty group ($Rho = 0.266$, $p = 0.142$).

Independence in activities of daily living followed the same overall pattern. Fewer patients in the hemiarthroplasty group were found to be dependent in activities of daily living at three-month follow-up than in the internal fixation group,¹² though the difference was not statistically significant ($p = 0.753$). We have now established that the association between MMSE at discharge and ability to perform daily activities at three-month follow-up (coded as an ordinal variable: 1=dependent, 2=partly-dependent, 3=independent) was much higher and only statistically significant in the internal fixation group ($Rho = 0.578$, $p = 0.001$) as compared

to the hemiarthroplasty group ($Rho=0.348$, $p=0.051$).

Similarly, it was previously found¹² that improvement in motor FIM subscore after three months tended to be (though not statistically significantly) larger in the hemiarthroplasty group (which we have now re-expressed as mean change from admission – hemiarthroplasty group: mean 34.8, SD 20.7; internal fixation group: mean 32.7, SD 20.4; $p=0.685$ from *t*-test), while we have now found that the correlation of improvement in motor FIM after three months with MMSE at admission was much higher and only statistically significant in the internal fixation group ($r=0.737$, $p<0.001$) as compared to the hemiarthroplasty group ($r=0.336$, $p=0.060$). Chow-type test indicated the difference in corresponding regression slopes to be close to statistical significance ($p=0.088$).

Finally, the preceding study¹² found that the Walking Ability Index (WAI, ranging from 1, indicating normal gait and unaided walking, to 6, indicating inability to travel a distance of 3 m even with walking aids) at discharge was lower (thus indicating better walking ability) in the hemiarthroplasty group (mean 5.3, SD 0.4) than in the internal fixation group (mean 5.6, SD 0.4; $p<0.001$ from *t*-test), while we have now established that WAI at discharge correlated with MMSE at admission only in the internal fixation group ($r=-0.477$, $p=0.007$) and not in the hemiarthroplasty group ($r=-0.008$, $p=0.965$). Likewise with the improvement in motor FIM, Chow-type test indicated the difference in corresponding regression slopes to be close to statistical significance ($p=0.068$).

Discussion

Epidemiological data indicate that the majority of femoral neck fractures occur in the elderly population, aged over 80 years.^{5,19} The victims are mainly women: because of reduced bone mineral density, their incidence is about fourfold that in men,¹⁹ whereby the main reason for fractures are falls. In this view, the prospective balanced nonrandomised study that provided the

data for our analyses addressed a representative sample, because the prevailing age was over 80 years and the patients were nearly all women. In addition, the equal-sized groups agreed with the population structure in the sense that clinical experience suggests both surgery types to be approximately equally frequent (with hemiarthroplasty being slightly more frequent, as it was also observed during the recruitment procedure, though we could not obtain long-term data).

Surgical treatment of femoral neck fracture enables early mobilisation of the patient, thus preventing complications associated with inactivity. Regardless of the surgery type, the goal of rehabilitation is to attain the best possible functional status, i.e., to return function as close as possible to the pre-injury level. The proportion of patients achieving pre-injury functional status is low – some estimate it to be only 25 %, ^{20,21} whereby cognitive decline is an important risk factor.^{22,23} Achieving a favourable functional outcome requires considerable physical fitness, motivation, and ability to co-operate and follow instructions during rehabilitation, all of which is hampered by cognitive decline.²⁴ Duration of hospital stay has been found to be longer, final functional outcome worse, and mortality higher in patients after femoral neck fracture who have cognitive decline.^{14,23-25} Similarly, dementia is more frequent in elderly patients with femoral neck fracture than in other hospitalised patients.¹⁴

Nevertheless, cognitive assessment is still frequently missing in patients with femoral neck fracture upon admission to hospital.^{26,27} Studies evaluating the importance of cognitive decline for functional outcome use different mental tests, but mainly the MMSE.^{17,28,29} That simple test used on admission can establish whether a patient has cognitive decline that could influence the final functional outcome.²² MSSE is also important for assessing the patient's ability to follow instructions and hence also for treatment planning.

Previous studies have mainly monitored walking ability (some also the ability to perform activities of daily living), whereby patients with cognitive decline were compared

to those without such signs, not taking into account surgery type.^{22,30} The first exception were Van Dortmond and associates, who published results from a prospective randomised clinical trial comparing internal fixation with hemiarthroplasty as the treatment for femoral neck fracture in patients with dementia in 2000.¹⁰ They found that the outcomes were unfavourable in both groups and deemed hemiarthroplasty too large a surgery to be performed in elderly patients with dementia. The same authors published results only from hemiarthroplasty treatment in the same patient population³¹ and concluded again that hemiarthroplasty was not appropriate for patients with cognitive decline.

However, in 2002, Rogmark and associates reported that one year after hemiarthroplasty of femoral neck fracture in elderly patients with cognitive decline, the functional outcome was better than in comparable patients treated with internal fixation.³² The patients treated with hemiarthroplasty walked better than those treated with internal fixation, and nearly half of them were able to walk like before the injury. The advantage of performing hemiarthroplasty in elderly patients with cognitive decline was subsequently confirmed through a meta-analysis of 14 randomised studies.³³ Similarly, in 2009, Olofsson and associates found that one year after femoral neck fracture among patients with cognitive decline, the group treated with hemiarthroplasty reached functional status closer to the pre-injury level than the group treated with internal fixation. The authors therefore concluded that dementia (or milder cognitive decline) should not be viewed as counter-indication for choosing the most adequate surgery type, but the presence of cognitive decline should nevertheless be diagnosed.³⁴ Finally, one year after surgery for femoral neck fracture in patients with signs of cognitive decline, better functional outcome was observed in those treated with hemiarthroplasty than in those treated with internal fixation as reported by Gjertsen and associates in 2010.³⁵ They recommend hemiarthroplasty for treating femoral neck fracture in patients with cognitive decline.

Our study took a slightly different approach, because in addition to the direct comparison of outcomes, which was presented in a preceding publication,¹² the association of cognitive status with the outcomes was compared between the two surgery types. The difference in correlation between MMSE at admission and walking distance at discharge between the groups, which we found, can be interpreted in the sense that in general, patients treated with hemiarthroplasty who had low MMSE scores were able to walk longer distances than patients treated with internal fixation who had equal cognitive decline. The reason for this may be related to the demand for transferring weight from the operated leg after internal fixation. Cognitive decline hampers comprehension of instructions, thus making the process of learning to walk more difficult, which slows down the course of rehabilitation. Such patients tend to remain less mobile, wheelchair-dependent or even bed-ridden, thereby reaching worse functional outcome at discharge from hospital.

The same holds for the other outcome measures. Direct (statistical tests of difference in regression slopes) or indirect evidence (clear differences in ordinal correlation and associated statistical significance) indicates that the association with MMSE score at admission was higher in the internal fixation group than in the hemiarthroplasty group for the ability to walk unassisted at discharge, the ability to walk outdoors at three-month follow-up, independence in activities of daily living at three-month follow-up, improvement in motor FIM subscore at three-month follow-up and WAI score at discharge. Hence, our results unanimously agree with the findings from the recent literature,³²⁻³⁵ which favour hemiarthroplasty in patients with cognitive decline.

The excellent comparability of the two groups, which was not unexpected but had to be verified, further supports the validity of our findings. It should also be noted that our association comparison approach is more valid than either a subgroup analysis of patients with low MMSE score, or dichotomisation of MMSE score for the purpose of subsequent comparison would have been.

However, the limited number of patients (24 in total, 12 in each group) with moderate to severe cognitive decline (i.e., MMSE scores below 20) limits the power and reliability of our conclusion concerning patients with cognitive decline, regardless of the statistical approach used. Nevertheless, it is precisely the difference among patients with low MMSE scores (of whom the number was equal in the two groups, as noted above) that contributes to the more favourable overall outcome of hemiarthroplasty (emphasised in the preceding publication¹² and summarised in the present paper). Our study therefore clearly suggests that hemiarthroplasty may be a better option than internal fixation for patients with low MMSE score.

Conclusion

Presence of cognitive problems adversely affects walking ability and functioning mainly in patients treated surgically with internal fixation after femoral neck fracture, and not (or to a much lesser extent) in patients treated with hemiarthroplasty. It is recommended to take this into account during surgical decision making.

References

1. Beaupre LA, Jones CA, Saunders LD, Johnston DW, Buckingham J, Majumdar SR. Best practices for elderly hip fracture patients. A systematic overview of the evidence. *J Gen Intern Med* 2005; 20: 1019–25.
2. Kozina S, Smrke D. Zlom vratu stegenice. *Med Razgl* 1999; 38: 103–15.
3. Kannus P, Parkkari J, Sievanen H, et al. Epidemiology of hip fractures. *Bone* 1996; 18: 57S–63S.
4. Cooper C, Campion G, Melton LJ. Hip fractures in the elderly: a worldwide projection. *Osteoporosis Int* 1992; 2: 285–9.
5. Marks R. Hip fracture epidemiological trends, outcomes, and risk factors, 1970–2009. *Int J Gen Med* 2010; 3: 1–17.
6. Guo Z, Wills P, Viitanen M, Fastbom J, Winblad B. Cognitive impairment, drug use, and the risk of hip fracture in persons over 75 years old: a community-based prospective study. *Am J Epidemiol* 1998; 148: 887–92.
7. Gjertsen JE, Vinje T, Lie SA, Engesaeter LB, Havlin LI, Furnes O, Fevang JM. Patient satisfaction, pain, and quality of life 4 months after displaced femoral neck fractures: a comparison of 663 fractures treated with internal fixation and 906 with bipolar hemiarthroplasty reported to the Norwegian Hip Fracture Register. *Acta Orthop* 2008; 79 (5): 594–601.
8. Koglot F, Štrbenc-Mozetič M, Beltram M. Zlom kolka pri starostniku. *Zdrav Vestn* 2001; 70: 661–3.
9. Brilej D, Komadina R, Vrabl M. Outcome in patients with femoral neck fractures depends on the treatment used. *Zdrav Vestn* 2007; 76 (S1): I-3–8.
10. Van Dortmont LM, Douw CM, van Breukelen AM, Laurens DR, Mulder PG, Wereldsma JC, van Vugt AB. Cannulated screws versus hemiarthroplasty for displaced intracapsular femoral neck fractures in demented patients. *Ann Chir Gynaecol* 2000; 89 (2): 132–7.
11. Rogmark C, Carlsson A, Johnell O, Sernbo I. A prospective randomised trial of internal fixation versus arthroplasty for displaced fractures of the neck of the femur. Functional outcome for 450 patients at two years. *J Bone Joint Surg Br* 2002; 84 (2): 183–8.
12. Kos N, Burger H, Vidmar G. Mobility and functional outcomes after femoral neck fracture surgery in elderly patients: a comparison between hemiarthroplasty and internal fixation. *Disabil Rehabil* 2011; 33 (23–24): 2264–71.
13. Folstein M, Folstein SE, McHugh PR. "Mini mental state". A practical method for grading the cognitive state of patients for the clinician. *J psychiatr Res* 1975; 12: 189–98.
14. Gruber-Baldini AL, Zimmerman S, Morrison RS, Grattan LM, Hebel JR, MM Dolan, Hawkes W, Magaziner J. Cognitive impairment in hip fracture patients: timing of detection and longitudinal follow-up. *J Am Geriatr Soc* 2003; 51 (9): 1227–36.
15. Vidmar G, Burger H, Marinček Č, Cugelj R. Analysis of data on assessment with the Functional Independent Measure at the Institute for Rehabilitation, Republic of Slovenia. *Inf Med Slov* 2008; 13 (1): 21–32.

16. Vidmar G, Burger H, Marinček Č. Time trends in ability level and functional outcome of stroke and multiple sclerosis patients undergoing comprehensive rehabilitation in Slovenia. *Zdrav Var* 2011; 50: 24–33.
17. Muir SW, Yohannes AM. The impact of cognitive impairment on rehabilitation outcomes in elderly patients admitted with a femoral neck fracture: a systematic review. *J Geriatr Phys Ther* 2009; 32 (1): 24–32.
18. Chow GC. Tests of equality between sets of coefficients in two linear regressions. *Econometrica* 1960; 28 (3): 591–605.
19. Rok Simon M. Epidemiologija zlomov pri starostnikih. In: Čokolič M, ed. *Zbornik referatov – I. osteološki dnevi*. Maribor: Univerzitetni klinični center Maribor; 2007. p. 90–102.
20. Koot VC, Peeters PH, De Jong JR, Clevers GJ, Van der Werken C. Functional results after treatment of hip fracture: a multicentre, prospective study in 215 patients. *Eur J Surg* 2000; 166: 480–5.
21. Cander-Parra E, Corcoles-Jimenez MP, Del Egidio-Fernandez MA, Villada-Munera A, Jimenez-Sanchez MD, Moreno-Moreno M, Carrion-Gonzales M, Denia-Cortes A. Independence in activities of daily living 6 months after surgery in previously independent elderly patients with hip fracture caused by a fall. *Enferm Clin* 2008; 18 (6): 309–16.
22. Soderqvist A, Miedel R, Ponzer S, Tidermark J. The influence of cognitive function on outcome after hip fracture. *J Bone Joint Surg* 2006; 88: 2115–23.
23. Kallin K, Gustafson Y, Sandman PO, Karlsson S. Factors associated with falls among older, cognitively impaired people in geriatric care settings: a population-based study. *Am J Geriatr Psychiatry* 2005; 13 (6): 501–9.
24. Givens JL, Sanft TB, Marcantonio ER. Functional recovery after hip fracture: the combined effects of depressive symptoms, cognitive impairment, and delirium. *J Am Geriatr Soc* 2008; 56 (6): 1075–9.
25. Holmes J, House A. Psychiatric illness predicts poor outcome after surgery for fracture: a prospective cohort study. *Psychol Med* 2000; 30: 921–9.
26. Gustafson Y. Postoperative delirium-a challenge for the orthopaedic team. *Acta Orthop Scand* 2004; 75: 375–7.
27. Soderqvist A, Stromberg L, Ponzer S, Tidermark J. Documenting the cognitive status of hip fracture patients using the Short Portable Mental Status Questionnaire. *J Clin Nurs* 2006; 15: 308–14.
28. Kaplan CP, Corrigan JD. The relationship between cognition and functional independence in adults with traumatic brain injury. *Arch Phys Med Rehabil* 1994; 75: 643–47.
29. Rolland Y, Pillard F, Lauwers-Cances V, Busquère F, Vellas B, Lafont C. Rehabilitation outcome of elderly patients with hip fracture and cognitive impairment. *Disabil Rehabil* 2004; 26: 425–31.
30. Feng L, Scherer SC, Tan BY, Chan G, Fong NP, Ng TP. Comorbid cognitive impairment and depression is a significant predictor of poor outcomes in hip fracture rehabilitation. *Int Psychogeriatr* 2010; 22 (2): 246–53.
31. Van Dortmont LM, Douw CM, van Breukelen AM, Laurens DR, Mulder PG, Wereldsma JC, van Vugt AB. Outcome after hemi-arthroplasty for displaced intracapsular femoral neck fracture related to mental state. *Injury* 2000; 31 (5): 327–31.
32. Rogmark C, Carlsson A, Johnell O, Sernbo I. Primary hemiarthroplasty in old patients with displaced femoral neck fracture: a 1-year follow-up of 103 patients aged 80 years or more. *Acta Orthop Scand* 2002; 73 (6): 605–10.
33. Rogmark C, Johnell O. Primary arthroplasty is better than internal fixation of displaced femoral neck fractures: a meta-analysis of 14 randomized studies with 2289 patients. *Acta Orthop* 2006; 77 (3): 359–67.
34. Olofsson B, Stenvall M, Lundström M, Gustafson Y, Svensson O. Mental status and surgical methods in patients with femoral neck fracture. *Orthop Nurs* 2009; 28 (6): 305–13.
35. Gjertsen JE, Vinje T, Engesaeter LB, Lie SA, Havelin LI, Furnes O, Fevang JM. Internal screw fixation compared with bipolar hemiarthroplasty for treatment of displaced femoral neck fractures in elderly patients. *J Bone Joint Surg Am* 2010; 92 (3): 619–28.