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RESEARCH ARTICLE

Internal Fixation *Versus* Hemiarthroplasty for Displaced Intra-Capsular Femoral Neck Fractures in ASA 3-5 Geriatric Patients

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Abstract:

Background:

The treatment of choice for elderly with a displaced intra-capsular femoral neck fractures is prosthetic replacement. This is however a major surgical procedure for geriatric patients with multiple co-morbidities which can threaten hemodynamic stability and lead to death. In this study we compared the outcome of internal fixation (IF) *versus* hemiarthroplasty (HA) for the management of intra-capsular femoral neck fractures in the elderly with severe co-morbidities.

Methods:

We conducted a retrospective cohort study of all the patients who were admitted to our Level-II trauma centre with a femoral neck fracture between January 2009 and June 2011. Inclusion criteria were: 70 years or older, ASA 3 or higher, a displaced femoral neck fracture and treatment with either internal fixation or a cemented hemiprosthesis. The primary outcome was 6-month mortality rate. Secondary outcomes were 30-day mortality, post-operative complications, re-operation rate and length of hospital stay.

Results:

80 patients met our inclusion criteria. The mean age of the IF group was 81.6 years and in the HA group it was 84.5 years ($P=0.07$). The medical records were retrieved 34-64 months after surgery. Two intra-operative deaths due to cement implantation syndrome were found in the HA group and none in the IF group. Twelve patients (21.8%) in the HA group died within 30 days after surgery and 2 (8.0%) in the IF group ($P=0.21$). The mean operating time was 83 min. for the HA group and 51 min. for the IF group ($P=0.000$). There were more implant-related complications in the IF than in the HA group (36% *vs* 9.1% respectively, $P=0.008$). The 6-month mortality rates didn't differ between the IF and the HA groups (respectively 28.0% *vs* 34.5%, $P=0.62$).

Conclusion:

The post-operative mortality rates did not differ between the IF and the HA groups in elderly patients with a displaced femoral neck fracture and ASA 3 to 5. However, the HA associated with less implant-related complications than the IF in this group and it is therefore the treatment of choice.

Keywords: Elderly, Femoral Fracture, Hemiarthroplasty, Internal Fixation, Morbiditymortality.

1. INTRODUCTION

Intra-capsular femoral neck fracture is one of the most common major musculoskeletal injuries of the aging population in most industrialized countries [1, 2]. The Intra-capsular femoral neck fracture in elderly is associated with a high incidence of mortality and morbidity. These fractures are associated with a 30-day mortality rate of 10% and one year mortality rate of 30% [3, 4].

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Hemiarthroplasty (HA) is the treatment of choice in older patients with a displaced femoral neck fracture [5 - 7]. Different studies demonstrated that a HA resulted in a lower likelihood of developing implant-related complications and consequent reoperations than internal fixation in this group [8 - 10]. HA has also better predictable functional and long-term outcomes [8 - 10]. However, the HA procedure in older patients with co-existing pathologies can increase the risk of intra- and post-operative mortality rates due to a long anaesthetic course, large surgical exposure, great blood loss and development of cement implantation syndrome [11 - 13]. Moreover, a number of patients are unfit for HA procedures due their fragile medical conditions [14 - 16]. Bone cement implantation syndrome is characterized with intra-operative cardiopulmonary disturbance, occurring around the time of cementation of femoral stem, which could lead to intra-operative death [11, 17, 18]. The clinical presentation of bone cement implantation syndrome varies from transient desaturation and hypotension to cardiac arrhythmias and cardiac arrest during cementation of stem [11]. Koessler *et al.* have shown that during this process, embolism may occur in 93% of patients [19]. Some authors demonstrated that cardiopulmonally unstable elderly patients with a high American Society of Anesthesiologists (ASA) score undergoing cemented arthroplasty are at risk for intra-operative death due to embolism [11, 20, 21]. Internal fixation procedures such as closed reduction of the fracture and internal fixation of displaced femoral neck fractures with three cannulated hip screws (CHS) or dynamic hip screw (DHS) are alternatives to hemiarthroplasty in high risk geriatric patients. This offers significant advantages in terms of minimal surgical trauma and prevention of cement implantation syndrome. Little is known about the effect of this technique on mortality in this specific group of patients. However, internal fixation is more often complicated with later displacement of de neck fracture, non-union and avascular necrosis [22, 23]. The aim of this study was to compare the surgical outcome in elderly with severe medical conditions and a displaced fracture of femoral neck who were treated either by IF or HA.

2. PARTICIPANTS AND METHODS

2.1. Patients

The inclusion criteria were: an age of 70 or older, a displaced intra-capsular femoral fracture, ASA (American College Anaesthesiology) classification 3 or higher and treatment with either IF, using 3 CHS (Stryker) or DHS (Stryker) or a cemented HA (Mathys femur stem). All patients registered in the hip trauma database who were treated for a femoral neck fracture between the first of January 2009 and 30th of June 2011 at a level 2 trauma hospital in the Netherlands were evaluated. Institutional approval was obtained for the use of medical records. The patients were classified according to age, gender, type of fracture, the time to surgery following admission, general health status according to ASA classification and surgical methods. The intra-capsular femoral neck fracture was classified to displaced and un-displaced fracture. The patients' general physical health status were assessed by the anaesthesiologist according to ASA classification before surgery. ASA 1 indicates a completely healthy person; ASA 2, a person with mild systemic disorder; ASA 3, a person with severe systemic disease that is incapacitating; ASA 4, a person with incapacitating disease that is a constant threat to life; ASA 5, a moribund patient who is not expected to live 24 h with or without surgery.

2.2. Surgical Technique

All operations in both groups were carried out by a trauma surgeon or a senior trainee under the direct supervision of a trauma surgeon. IF or HA was chosen depending on the preference of the surgeon. Internal fixation was performed with the patient lying supine on a fracture table with the aid of image intensifier. The fractures were reduced closely and fixed internally by means of three CHS 7.3 mm (Stryker) or DHS (Synthes) according to the recommendations of AO. In case of hemiprosthesis, a cemented Mathys implant was inserted, using the anterolateral approach in the HA group. A geriatric consultant and anaesthetic consultant reviewed all patients prior to the surgery on the weekdays. At the weekend and holidays, patients were reviewed solely by anaesthetic consultant. The patients consequently are prepared as necessary before transfer to the operating theatre. All patients were given ceftriaxon (1.5 grams) pre-operatively and 2500IE of low molecular weight heparin (Fragmin) for six weeks post-operatively. On weekdays, all patients reviewed daily by the ward-based trainee and geriatric team and the patients were mobilised under direct supervision of physiotherapist. On weekend, patients reviewed just by on call surgical trainee and there was no geriatric or regular physiotherapist support.

2.3. Outcomes

The primary outcome was the mortality rate within six months after the operation. We tracked this using the

Netherlands personal registration system. It is a local policy to note all surgical complications including benign complications in a patient's electronic record. The medical records including surgical and anaesthetic data were retrieved 34-64 months after surgery (mean: 51.7 month). Intra-operative details such as mean anaesthetic and operating time were also recorded. Clinical follow up was ended at 6 weeks post-operative in asymptomatic patients. Secondary outcomes are intra-operative mortality, in-hospital mortality, mortality rate within 30 days and first year after surgery, length of hospital stay, implant-related complications, general complications and re-operation rate. General complications included cardiac, pulmonary, thromboembolic and cerebrovascular events. Implant-related complications included wound bleeding, hematoma requiring blood transfusion, wound infection requiring antibiotic or surgical intervention, protrusion or promination of screw, intra-operative fracture, re-displacement of fracture, symptomatic collapse of femur head, non-union, avascular necrosis, dislocation of prosthesis, prosthesis loosening, intra-operative fracture, peri-prosthetic fracture and pain without clarification.

3. DATA ANALYSIS

The statistical software used was SPSS version 20 for Mac OS. Nominal variables were tested with the Fisher's exact test. Continues variables were tested with the Mann-Whitney-U test. All tests were two sided. The results were considered significant at a two-tailed level of 0.05. The age, sex and ASA score, which are known to be associated with raised mortality, defined as cofounder and are adjusted in multivariate regression analysis. The Kaplan Meier analysis was used to analyse patients data related to mortality

4. RESULTS

Between the first of January 2009 and 30th of June 2011, 326 patients underwent a surgical procedure for an intra-capsular femoral neck fracture: 173 underwent hemiarthroplasty (HA), 11 underwent total hip replacement (THR), 96 underwent closed reduction and internal fixation with Canulated Hip Screws (CHS) and 46 underwent closed reduction and internal fixation with Dynamic Hip Screw (DHS). In total, 80 patients met the inclusion criteria. Nineteen patients were treated with internal fixation with CHS, 6 with internal fixation with DHS and 55 patients with HA. Baseline demographic and clinical characteristics in the two groups are presented in Table 1. The mean age of the patients in the IF group was 81.6 years and in the HA group was 84.5 years (P=0.07). There were no significant differences in demographic characteristics between groups. A total of 7 trauma surgeons were involved in the procedures. There were no significant differences in complication rates or mortality rates of patients treated by the different surgeons.

Table 1. Demographic and clinical details of the study population (n=80).

	Internal Fixation with CHS or DHS	Hemiarthroplasty	P value
Number	25	55	
Age (mean±SD)	81.6±6.2	84.5±6.5	0.07
Gender	10 (40.0%)	20 (36.4%)	0.80
Male	15 (60.0%)	35 (63.6%)	
Female			
ASA	21 (84.0%)	52 (94.5%)	0.20
III	4 (16.0%)	3 (5.5%)	
IV+V			
Time to Surgery*	32±15	25±15	0.12
Type of anaesthesia	0 (0.00%)	2 (4.2%)	1.00
Spinal	23 (100%)	46 (95.8%)	
General	2	7	
Missing data			
Mean difference post- and pre-operative haemoglobin **	0.48±0.53	1.08±0.67	0.000
Mean length of anaesthesia***	94±25	119±36	0.003
Mean length of Operation***	51±23	83±28	0.000

ASA= American Society of Anaesthesiology IF= Internal Fixation CHS= Canulated Hip Screw DHS= Dynamic Hip Screw HA= Hemiarthroplasty
*hours **gram/ dLit ***minutes

The Table 2 demonstrates the surgical outcomes in two groups. The mean operating time was shorter in the IF group (51 minutes vs 83 minutes; P=0.000).

Table 2. Surgical outcomes in the study population.

	Internal Fixation	Hemiarthroplasty	P value
Hospital stay Mean	8±6	9±6	0.49
Implant-related complication	9(36%)	5 (9.1%)	0.008
Re-operation rate	4 (16%)	2 (3.6%)	0.07
General complication	6 (24%)	20 (36.4%)	0.31
Mortality in hospital	2 (8.00%)	6 (10.9%)	1.0
Mortality within 30 days	2 (8.00%)	12 (21.8%)	0.21
Mortality within 6 months	7 (28.0%)	19 (34.5%)	0.62
Mortality within one year	8 (32.0%)	25 (45.5%)	0.33

The mean anaesthetic time in the IF group was shorter than the HA group (94 minutes vs 119; P=0.003). The post-operative haemoglobin decrease in the IF group was smaller than the HA group (0.48 vs 1.08 gram/ dLit; P= 0.000). The mean hospital stay did not vary significantly between the two groups. (8 vs 9 days; P=0.49). There was no significant difference between the two groups in the rates of general complications (24% vs 36.4% complications; P= 0.31). The Table 3 shows details of general complications in both groups. There was a significant difference between two groups in the rates of implant-related complication. Nine patients in the IF group and 5 patients in the HA group developed an implant-related complication (36% vs 9.1%, P= 0.008). The Table 4 illustrated the characteristic of Implant-related complications in the IF and HA groups. The re-operation rate did not differ between two groups (16% vs 3.6%, P=0.07). Four of the 25 patients in the IF group required a reoperation during the follow up. There were two cases of loss of reduction in the IF group, which was treated by conversion to HA. Two cases required replacement of screws with a shorter one because of intra-articular placement of the screws. One patient in the HA group underwent resection arthroplasty due to chronic implant infection. Other patient in the HA group was revised to total hip replacement due to aseptic femoral loosening. The 30-day mortality rate did not differ significantly in the HA group compared to the IF group (8.0% vs 21.8%, P= 0.21). There was no difference between two groups in the mortality rates during the hospital stay. There was no significant difference between the groups in patient survival after 30 days; 72.0% of the patients undergoing IF and 65.5% of the patients undergoing HA were still alive at 6 month follow up (P= 0.62) (Fig. 1).

Table 3. Characteristic of general complications in the IF and HA groups.

	Internal Fixation Group		Hemiarthroplasty Group	
	No	%	No	%
Delirium	0	0	5	9.1
Renal Insufficiently	1	4	2	3.6
Respiratory Infection	1	4	2	3.6
Pulmonary Eembolism	0	0	2	3.6
Cardial Event	1	4	0	0
In-hospital death	2	8	7	12.7
Urinary Tract Infection	1	4	0	0
Not Specified	0	0	2	3.6

Table 4. Characteristic of Implant-related complications in the IF and HA groups.

	Internal Fixation Group		Hemiarthroplasty Group	
	No	%	No	%
Wound Infection	0	0	1	1.8
Implant Loosening	0	0	2	3.6
Peri-prosthetic fracture	0	0	1	1.8
Intra-operative fracture	0	0	1	1.8
Protrusion or Prominence of screw	4	16	0	0
Non-union	1	4	0	0
Avascular femoral head necrosis	4	16	0	0

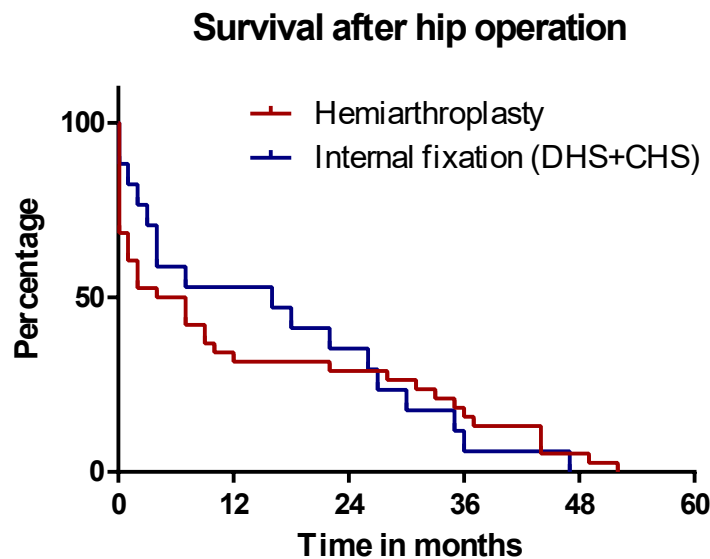


Fig. (1). Survival of patients (Kaplan- Meier) in months for internal fixation and hemiarthroplasty groups.

5. DISCUSSION

There are few studies, which compared the surgical outcomes of internal fixation *versus* hemiarthroplasty for an intra-capsular femoral neck fractures. However, to our knowledge, this is one of very few studies that made a comparison between two treatment conditions in a specific patient group, namely, frail elderly patients (70 years or older with ASA 3 or higher) with a displaced intra-capsular femoral neck fractures. The post-operative mortality rates within 30 days, 6 months and one year were comparable in two groups. This study illustrated that IF did not improved survival rates compared to the HA for displaced intra-capsular fractures of the femur in elderly patients with ASA 3 to 5. Soderqvist *et al.* reported a mortality rate of 4% during hospitalization period, 16% at 4 month and 38% at 24 month follow up [24]. In our study there was a higher mortality rate compared to the literature, but this can be explained by the fact that we only included seriously ill elderly with high ASA scores [5, 12, 23].

Many other studies also failed to find a significant difference in mortality rate between the IF and the HA, while patients with different ASA scores were included.

Further, our study demonstrated a less surgical trauma in terms of operating time, anaesthetic time, and blood loss, which is consistent with the findings of other studies [6, 23]. In our study, two patients (2.7%) in the HA groups died intra-operatively, one due a cardiac arrest and one due an ARDS, which initiated during cementing. Parvizi *et al.* suggested that the HA in older patient is associated with significant higher risk for developing cement implantation syndrome. According to our study, four other patients (8.2%) in the HA groups died during the hospital stay: two due to progressive cardiac failure, one due to myocardial infarction, and one due to irreversible malnutrition and multiple pressure sores.

In this cohort, we reported an implant-related complication rate of 36% in the IF group and 9.1% in the HA group. The implant-related complications in the IF group included four cases of protrusion or promination of screw, four cases of avascular necrosis of caput femoris, and one case of non-union. The reported complications in the HA group included two cases of aseptic loosening of prosthesis, two cases of intra-operative fractures, one case of infection and one case of secondary coxarthrosis. This failure rate is comparable with the findings of most previous studies [6, 23]. Although, the failure of IF can be treated by revision operation, this secondary operation is undesirable in frail elderly. Therefore, the HA is still the preferred procedure for a displaced femoral neck fracture in elderly patients due a lower rate of implant-related complications and consequent reoperations than internal fixation with IF [8 - 10].

Our IF study group was of limited size and in general the preferred choice of procedure was the HA. We are aware that a larger sample size for this study is desirable, however this study yielded some interesting observations. The major limitation of this study was the fact that the patients were not randomised to the two groups and the operative technique was chosen by the individual surgeon, whose decision may have been influenced by the patient's comorbidity and

frailty. However, the results of a Randomised Control Trial (RCT) can not be generalised to all patients with a hip fracture, due the potential exclusion of frail elderly patients, who may lack the capacity to give informed consent. Due to retrospective character of this cohort, it was difficult to track all the relevant data of functional outcomes. A prospective study might include a comparison of the postoperative mobility and patient satisfaction in both procedures.

CONCLUSION

A hemiarthroplasty is the treatment of choice for a displaced intra-capsular femoral neck fracture in elderly, which is in keeping with existing guidance. The IF is associated with more implant-related complications than the HA in treatment of a displaced femoral neck fracture in elderly patients with ASA 3 or higher. There is no evidence that IF can improve the post-operative mortality rates, although IF not associated with intra-operative adverse events due to a cement implantation syndrome.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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REFERENCES

- [1] Raaymakers EL. Fractures of the femoral neck: a review and personal statement. *Acta Chir Orthop Traumatol Cech* 2006; 73(1): 45-59. [PMID: 16613748]
- [2] Richmond J, Aharonoff GB, Zuckerman JD, Koval KJ. Mortality risk after hip fracture. *J Orthop Trauma* 2003; 17(1): 53-6. [<http://dx.doi.org/10.1097/00005131-200301000-00008>] [PMID: 12499968]
- [3] van Dortmont LM, Douw CM, van Breukelen AM, *et al.* Outcome after hemi-arthroplasty for displaced intracapsular femoral neck fracture related to mental state. *Injury* 2000; 31(5): 327-31. [[http://dx.doi.org/10.1016/S0020-1383\(99\)00304-6](http://dx.doi.org/10.1016/S0020-1383(99)00304-6)] [PMID: 10775686]
- [4] 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. [<http://dx.doi.org/10.1136/bmj.38643.663843.55>] [PMID: 16299013]
- [5] Onnerfält R. Treatment of the displaced femoral neck fracture, as reflected in *Acta Orthopaedica Scandinavica*. *Acta Orthop* 2010; 81(1): 15-20. [<http://dx.doi.org/10.3109/17453671003635801>] [PMID: 20170419]
- [6] Parker MJ, Khan RJ, Crawford J, Pryor GA. Hemiarthroplasty *versus* internal fixation for displaced intracapsular hip fractures in the elderly. A randomised trial of 455 patients. *J Bone Joint Surg Br* 2002; 84(8): 1150-5. [<http://dx.doi.org/10.1302/0301-620X.84B8.13522>] [PMID: 12463661]
- [7] Sendtner E, Renkawitz T, Kramny P, Wenzl M, Grifka J. Fractured neck of femur internal fixation *versus* arthroplasty. *Dtsch Arztebl Int* 2010; 107(23): 401-7. [PMID: 20589205]
- [8] Støen RØ, Lofthus CM, Nordsletten L, Madsen JE, Frihagen F. Randomized trial of hemiarthroplasty *versus* internal fixation for femoral neck fractures: no differences at 6 years. *Clin Orthop Relat Res* 2014; 472(1): 360-7. [<http://dx.doi.org/10.1007/s11999-013-3245-7>] [PMID: 23975250]
- [9] Murphy DK, Randell T, Brennan KL, Probe RA, Brennan ML. Treatment and displacement affect the reoperation rate for femoral neck fracture. *Clin Orthop Relat Res* 2013; 471(8): 2691-702. [<http://dx.doi.org/10.1007/s11999-013-3020-9>] [PMID: 23640205]
- [10] van den Bekerom MP, Sierevelt IN, Bonke H, Raaymakers EL. The natural history of the hemiarthroplasty for displaced intracapsular femoral neck fractures. *Acta Orthop* 2013; 84(6): 555-60. [<http://dx.doi.org/10.3109/17453674.2013.867763>] [PMID: 24286565]
- [11] Donaldson AJ, Thomson HE, Harper NJ, Kenny NW. Bone cement implantation syndrome. *Br J Anaesth* 2009; 102(1): 12-22. [<http://dx.doi.org/10.1093/bja/aen328>] [PMID: 19059919]
- [12] 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. [PMID: 6723159]
- [13] Sexson SB, Lehner JT. Factors affecting hip fracture mortality. *J Orthop Trauma* 1987; 1(4): 298-305. [<http://dx.doi.org/10.1097/00005131-198701040-00005>] [PMID: 3506066]
- [14] Bosch U, Schreiber T, Skutek M, Cserhádi P, Fekete K, Krettek C. Minimally invasive screw fixation of the intracapsular femoral neck

- fracture in elderly patients. *Chirurg* 2001; 72(11): 1292-7.
[<http://dx.doi.org/10.1007/s001040170034>] [PMID: 11766653]
- [15] Galla M, Lobenhoffer P. The minimally-invasive screw osteosynthesis of the medial femoral neck fracture in the very old. A prospective clinical study. *Unfallchirurg* 2004; 107(5): 381-7.
[PMID: 15221073]
- [16] Sträuli C, Seekamp A, Lehmann U, Bosch U. Bone screw osteosynthesis of medial femoral neck fracture in elderly patients. *Swiss Surg* 2001; 7(4): 167-72.
[<http://dx.doi.org/10.1024/1023-9332.7.4.167>] [PMID: 11515191]
- [17] Rutter PD, Panesar SS, Darzi A, Donaldson LJ. What is the risk of death or severe harm due to bone cement implantation syndrome among patients undergoing hip hemiarthroplasty for fractured neck of femur? A patient safety surveillance study. *BMJ Open* 2014; 4(6): e004853.
[<http://dx.doi.org/10.1136/bmjopen-2014-004853>] [PMID: 24924418]
- [18] Tryba M, Linde I, Voshage G, Zenz M. Histamine release and cardiovascular reactions to implantation of bone cement during total hip replacement. *Anaesthetist* 1991; 40(1): 25-32.
[PMID: 1706562]
- [19] Koessler MJ, Fabiani R, Hamer H, Pitto RP. The clinical relevance of embolic events detected by transesophageal echocardiography during cemented total hip arthroplasty: a randomized clinical trial. *Anesth Analg* 2001; 92(1): 49-55.
[<http://dx.doi.org/10.1097/0000539-200101000-00010>] [PMID: 11133599]
- [20] Parvizi J, Holiday AD, Ereth MH, Lewallen DG. The Frank Stinchfield Award. Sudden death during primary hip arthroplasty. *Clin Orthop Relat Res* 1999; (369): 39-48.
[<http://dx.doi.org/10.1097/00003086-199912000-00005>] [PMID: 10611859]
- [21] Pietak S, Holmes J, Matthews R, Petrusek A, Porter B. Cardiovascular collapse after femoral prosthesis surgery for acute hip fracture. *Can J Anaesth* 1997; 44(2): 198-201.
[<http://dx.doi.org/10.1007/BF03013009>] [PMID: 9043733]
- [22] Lu-Yao GL, Keller RB, Littenberg B, Wennberg JE. Outcomes after displaced fractures of the femoral neck. A meta-analysis of one hundred and six published reports. *J Bone Joint Surg Am* 1994; 76(1): 15-25.
[<http://dx.doi.org/10.2106/00004623-199401000-00003>] [PMID: 8288658]
- [23] Parker MJ. The management of intracapsular fractures of the proximal femur. *J Bone Joint Surg Br* 2000; 82(7): 937-41.
[<http://dx.doi.org/10.1302/0301-620X.82B7.11595>] [PMID: 11041577]
- [24] Söderqvist A, Ekström W, Ponzer S, *et al.* Prediction of mortality in elderly patients with hip fractures: a two-year prospective study of 1,944 patients. *Gerontology* 2009; 55(5): 496-504.
[<http://dx.doi.org/10.1159/000230587>] [PMID: 19628932]