J Surg Med. 2022;6(3):218-222.
DOI: 10.28982/josam.1057570

Journal of Surgery and Medicine
e-ISSN=2602-2079

In the fixation of adult femoral neck fractures, does percutaneous hematoma drainage have an effect on bone union?

Recep Dinçer [1], Anıl Gülcü [2]

[1] Suleyman Demirel University Faculty of Medicine, Department of Orthopedics and Traumatology, Isparta, Turkey
[2] Alaaddin Keykubat University Faculty of Medicine, Department of Orthopedics and Traumatology, Alanya, Antalya, Turkey

ORCID ID of the author(s)
RD: 0000-0001-9088-3940
AG: 0000-0002-9012-8053

Corresponding Author
Recep Dinçer
Suleyman Demirel University Faculty of Medicine, Department of Orthopedics and Traumatology, Isparta, Turkey
E-mail: recebed@gmail.com

Ethics Committee Approval
The study was approved by Suleyman Demirel University, Faculty of Medicine Clinical Research Ethics Committee Chair, Number: 33429/13.02.2021.
All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of Interest
No conflict of interest was declared by the authors.

Financial Disclosure
The authors declared that this study has received no financial support.

Published
2022 February 20

Abstract

Background/Aim: Major blood circulation of the femur head is provided by retrograde flow from the medial femoral circumflex artery. The biggest problem here is uncertainty that the fracture hematoma disrupts the feeding of the femoral head. The aim of this study was to evaluate the effect on bone union of percutaneous hematoma punction in femoral neck fractures in patients aged <60 years and in patients with similar fracture types operated on in similar periods and to compare the outcomes in respect of complications.

Methods: In this retrospective cohort study, from a total of 58 patients who presented at the Orthopedics and Traumatology Clinic of a tertiary level training and research hospital between January 2014 and December 2018 and were diagnosed with intracapsular femoral neck fracture, the study included 49 patients who met the inclusion criteria and had follow-up of at least 1 year. In the treatment of all the fractures, 3 cannulated spongious screws were used. Percutaneous hematoma drainage was applied to 25 patients [Hem (+)=Group 1], and was not applied to 24 patients [Hem (-)=Group 2]. The patients were separated into two groups as those with and without fracture hematoma. The demographic data, time to union and femoral neck anatomic parameters were statistically compared between the two groups. Clinical and radiographic evaluations were made at the end of postoperative 1 month, 3 months, 6 months and 1 year. The Harris Hip Score was used in the clinical evaluation.

Results: The mean follow-up period was 21 months (range, 12-36 months). Group 1 comprised 18 (72%) females and 7 (28%) males with a mean age of 38 years (range, 19-53 years), and Group 2 comprised 16 (66%) females and 8 (34%) males with a mean age of 40 years (range, 19-58 years) (age: P=0.483). In Group 1, the right side was affected in 14 patients (56%) and the left side in 11 (44%). In Group 2, the right side was affected in 14 patients (58%) and the left side in 10 (42%) (P=0.869). A mean of 28 cc hematoma was drained from Group 1. In 47 patients, the operation was performed within the first 24 hours. The fractures were determined as Garden type 3 in 52% (n=13) of Group 1 and in 54% (n=13) of Group 2 (P=0.940). Full bone union was obtained in 80% (n=20) of Group 1 and in 79% (n=19) of Group 2 (P=0.728). Revision surgery was required in 7 patients in Group 1 and in 3 patients in Group 2. At the final follow-up examination, the difference between the healthy side and the fractured side femoral neck offset values were calculated. The difference in femoral offset compared with the healthy non-operated side was -3.48 (9.44) mm in Group 1, and -2.25 (7.97) mm in Group 2 (P=0.625). No significant difference was determined between the groups in respect of the anatomic parameters after union. The Harris Hip Scores were determined as mean 89 (range, 63-98) in Group 1 and 91 (range, 64-98) in Group 2 (P=0.616). No statistically significant difference was determined between the groups in respect of the clinical evaluation. Avascular necrosis developed in the femoral head in 4 (16%) patients in Group 1 and in 1 (4.17%) in Group 2 (P=0.349).

Conclusion: From the results of this study it was seen that unlike hematoma formed in extremity fractures, hematoma in femoral neck fractures has an effect that makes union difficult rather than facilitating callus formation. Hematoma punction led to an increased risk of avascular necrosis with impaired intraosseous circulation flowing in reverse to the femoral head due to negative pressure formed in the fracture line.

Keywords: Femoral neck fracture, Intracapsular fracture, Cannulated screw, Fracture hematoma, Hematoma punction

How to cite: Dinçer R, Gülcü A. In the fixation of adult femoral neck fractures, does percutaneous hematoma drainage have an effect on bone union? J Surg Med. 2022;6(3):218-222.

Introduction

Intracapsular femoral neck fractures in young adults account for approximately 3% of the total hip fracture population [1, 2]. Major blood circulation of the femur head is provided by retrograde flow from the medial femoral circumflex artery (MFCA). Unlike intracapsular femoral neck fractures in the elderly, these fractures in the younger population result from high-energy trauma and vascular damage associated with the fracture has a significant effect on femoral head perfusion [3]. Therefore, the treatment of femoral neck fractures continues to be a significant clinical challenge.

The selection of the options of arthroplasty or internal fixation in treatment must be decided taking into consideration the age, bone quality, activity level, and general condition of the patient [4]. If open reduction and internal fixation is selected in respect of a good anatomic and clinical outcome, the vascular pathology should be well understood. Internal fixation is the recommended surgical treatment for non-displaced fractures in patients aged <60 years [3]. The most commonly used fixation material in non-displaced femoral neck fractures is multiple cannulated spongious screws. The most accepted procedure is 3 cannulated screws placed parallel or cranial based in a triangular shape to provide controlled compression of the fracture ends [5].

Major complications in these fractures are implant failure, non-union, and femoral head avascular necrosis (AVN). Direct damage to the retinacular vessels at the time of fracture or the possible tamponade effect of intracapsular hematoma can lead to AVN [6]. There are studies in literature that have determined intracapsular pressure as this tamponade effect [4, 6]. In the general trauma approach, it is aimed to protect the fracture hematoma as much as possible, as one of the factors facilitating fracture union. However, it has been stated that unlike in femoral neck fractures, by increasing intracapsular pressure, femoral neck fracure hematoma impairs vascular support and is one of the factors leading to AVN.

The aim of this study was to evaluate the effect on union of percutaneous hematoma punction in femoral neck fractures in patients aged <60 years and in patients with similar fracture types operated on in similar periods and to compare the outcomes in respect of non-union and avascular necrosis.

Materials and methods

Approval for this study was granted by the Suleyman Demirel University Faculty of Medicine Clinical Research Ethics Committee (decision no: 72867572-050.01.04-33429, dated: 12.02.2021).

In the period between January 2014 and December 2018, a total of 58 patients presented at the Orthopedics and Traumatology Clinic of a tertiary level training and research hospital and were diagnosed with femoral neck fracture.

The study exclusion criteria were defined as age <18 years or >65 years, pathological fracture, fractures of a bone with incomplete maturation, operations performed following a period in the intensive care unit because of multiple organ damage, open reduction, the use of implants other than cannulated screw, and hemodynamic instability. A total of 9 patients were excluded from the study; 5 who were aged <18 years and 4 who could not be contacted.

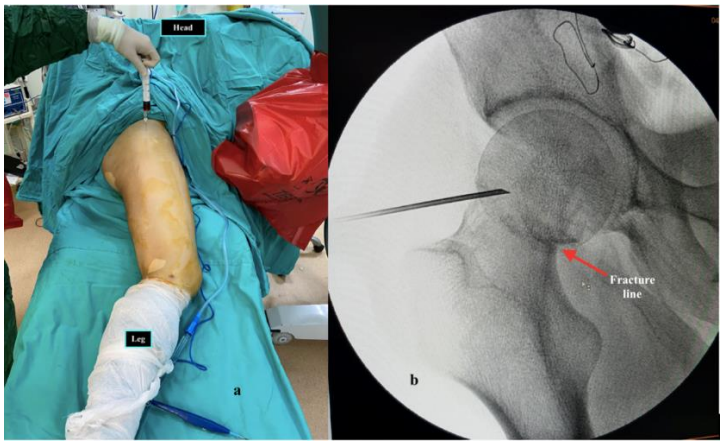
Thus, 49 patients, who met the inclusion criteria and had follow-up of at least 1 year, were included in the study for comparisons of the clinical and radiological data.

On first presentation, standard anterior-posterior (AP) pelvis radiographs and hip-femur radiographs were taken of all patients. Computed tomography (CT) was used to determine the status of fragments in displaced fractures. Classification of the fractures was made according to the Garden and Pauwel classifications [8, 9].

All the patients were examined in respect of demographic data such as age and gender (Table 1), union status, follow-up period, and whether or not percutaneous punction was performed in the fracture field. All the preoperative, intraoperative, and postoperative records of the patients were examined.

With the exception of two patients, the operations were performed within the first 24 hours. All the patients were operated on in the lateral decubitus position. The patients were separated into two groups as those who were applied with percutaneous hematoma punction with a spinal needle under intraoperative fluoroscopy guidance, and those who did not undergo hematoma punction (Figure 1).

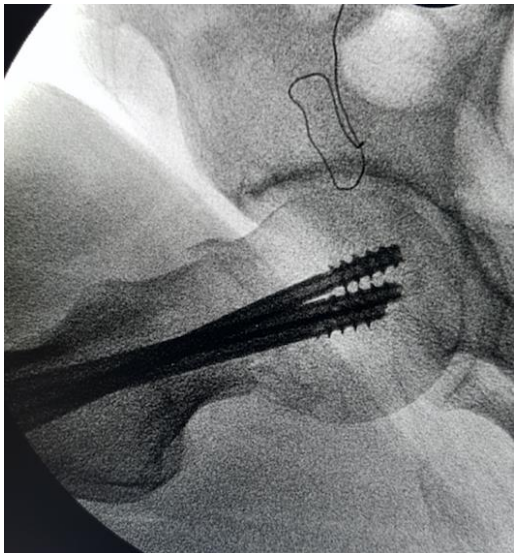
Figure 1: Intraoperative fluoroscopic view of hematoma drainage from the fracture line.



Application of percutaneous hematoma drainage from the anterolateral region with a spinal needle in the lateral decubitus position (a) under the guidance of intraoperative fluoroscopy (b).

At 30 mins before the operation all the patients were administered 1 gr cefazoline intravenously as prophylaxis. As the surgical method, closed reduction and fixation with cannulated screws was applied to all patients (Figure 2). Standard fixation was applied with 3 cannulated screws. Postoperatively, thromboembolism prophylaxis of low-molecular weight heparin (enoxaparin) was started for all patients at a weight-adjusted dose. Immediately postoperatively, anti-embolic stockings were applied to both lower extremities. Within the standard protocol, AP pelvis digital radiographs were taken on the first postoperative day. Pelvis AP radiographs were taken with the patient supine, the extremities in 10°-15° internal rotation and centered on the symphysis pubis. Patients were mobilized on the postoperative first day with no weight-bearing on the operated side.

Figure 2: Intraoperative fluoroscopic lateral view



Standard fixation was applied with 3 cannulated screws. The lateral fluoroscopic view shows ideal reduction.

Clinical and radiographic evaluations were made at the end of postoperative 1 month, 3 months, 6 months, and 1 year. Radiological bone union was checked on the full pelvis AP radiographs. In cases of delayed union or when there was thought to be impaction on the radiograph, the hip joint was evaluated with CT. The following measurements were compared with the healthy non-operated side:

1. Femoral lateral offset, stated as the horizontal distance between the femur shaft anatomic axis and the center of hip rotation
2. Head-neck angle, stated as the angle between the femur shaft and the line drawn from the center of the proximal of the femoral neck fracture
3. Femoral head-intertrochanteric distance, stated as the distance between the intertrochanteric line and the center of the femoral head.

Statistical analysis

Data obtained in the study were analyzed statistically using IBM SPSS v. 23.00 software. Conformity of quantitative data to normal distribution was assessed with the Kolmogorov-Smirnov test. Variables with normal distribution were compared using the Student's t-test and data not showing normal distribution with the Mann Whitney U-test and the Kruskal Wallis test. Categorical variables were statistically compared with Chi-square analysis and descriptive statistics were shown as number (n) and percentage (%). Correlations between variables were examined with the Pearson correlation test and linear regression analyses. A value of $P<0.05$ was accepted as statistically significant.

Results

In this retrospective cohort study, evaluation was made of 49 patients with intracapsular femoral neck fracture. The mean follow-up period was 21 months (range, 12-36 months). Percutaneous hematoma drainage (mean 28cc) was applied to 25 patients (Group 1), and was not applied to 24 patients (Group 2). The mean age of the patients was 38 years (range, 19-53 years) in Group 1 and 40 years (range, 19-58 years) in Group 2. In 47 patients, the operation was performed within the first 24 hours. Spinal anesthesia was applied to all the patients. The mean operating time was 63 mins (range, 45-110 mins). The mean length of hospital stay was 3 days. All the patients were mobilized on postoperative day 1.

The fractures were determined as Garden type 3 in 52% (n=13) of Group 1 and in 54% (n=13) of Group 2 (Table 1). Full bone union was obtained in 80% (n=20) of Group 1 and in 79% (n=19) of Group 2. Comorbid diseases were present in 96% of the patients in Group 1, and in 87.5% of Group 2. Revision surgery was required in 7 patients in Group 1 and in 3 patients in Group 2. Compared with the non-operated side, the difference in femoral head intertrochanteric distance was determined as -6.12 (6.59) mm in Group 1, and -5.83 (5.06) mm in Group 2 ($P=0.866$). The difference in femoral offset compared with the healthy non-operated side was -3.48 (9.44) mm in Group 1, and -2.25 (7.97) mm in Group 2 ($P=0.625$). The difference in head-neck angle between the operated and healthy sides was -2.6° (7.69°) in Group 1 and -3.5° (9.22°) in Group 2 ($P=0.712$). No significant difference was determined between the groups in respect of the anatomic parameters after union.

Table 1: Demographic data of the patients

	Group 1	Group 2	*P*-value
Age	38 (19-53)	40 (19-58)	0.483
Side			0.869
Right	14 (56%)	14 (58%)	
Left	11 (44%)	10 (42%)	
Sex			0.686
Female	18 (72%)	16 (66%)	
Male	7 (28%)	8 (34%)	
Garden Type			0.940
2	4 (16%)	3 (13.5 %)	
3	13 (52%)	13 (54.1%)	
4	8 (32%)	8 (32.4%)	
Union			0.728
+	20 (80%)	19 (79%)	
-	5 (20%)	5 (21%)	
Union Time (week)	17 (8-32)	16 (9-20)	0.762

Group 1: Percutaneous Hematoma Drainage was applied, Group 2: Percutaneous Hematoma Drainage was not applied. *$P<0.05$ statistically significant

The Harris Hip Score (HHS) was used in the postoperative evaluations. The mean HHS was determined as 89 (range, 63-98) in Group 1 and 91 (range, 64-98) in Group 2 ($P=0.616$). No statistically significant difference was determined between the groups in respect of the clinical evaluation. Avascular necrosis developed in the femoral head in 4 (16%) patients in Group 1 and in 1 (4.17%) in Group 2 ($P=0.349$) (Table 2).

Table 2: Results of anatomical and clinical parameters

	Mean (SD)	Med (min - max)	Mean (SD)	Med (min - max)	*P*-value
	Group 1		Group 2		
Garden	3.16 (0.69)	3 (2 - 4)	3.21 (0.66)	3 (2 - 4)	0.816
Pauwal	2.84 (0.37)	3 (2 - 3)	2.83 (0.38)	3 (2 - 3)	0.95
FH-ID	-6.12 (6.59)	-6 (-17 - 4)	-5.83 (5.06)	-5 (-16 - 2)	0.866
femoral offset	-3.48 (9.44)	-2 (-24 - 12)	-2.25 (7.97)	-2.5 (-22 - 12)	0.625
FH-NA	-2.6 (7.69)	-2 (-22 - 9)	-3.5 (9.22)	-3 (-22 - 11)	0.712
Harris HS	86.88 (9.46)	89 (63 - 98)	87.96 (8.96)	91 (64 - 98)	0.616

FH-ID: Distance between femoral head and intertrochanteric line, fem. offset: femoral offset, FH-NA: angle between femoral head and femoral neck, HHS: Harris hip score. *$P<0.05$ statistically significant; t: Independent Samples t test; SD: Standard Deviation; Med (min – max): Median (minimum – maximum values).

Discussion

In this study, the effect of fracture hematoma was examined on bone union and anatomic parameters in patients with a diagnosis of intracapsular femoral neck fracture who were operated on within the first 24 hours. The results of the study demonstrated that in the comparison of the two groups, in which mean age and fracture type were very similar, the anatomic parameters (femoral offset, femur neck angle, femoral head-intertrochanteric line distance) were increased in Group 1

compared to Group 2. The time to union was longer in Group 1 than in Group 2, but not to a statistically significant level. It was concluded that fracture hematoma drainage led to an amount of impairment in the anatomy and to a slight delay in bone union.

The general approach in non-displaced intracapsular femoral neck fractures is closed reduction and in situ fixation. Cannulated screws and dynamic hip screws (DHS) are the fixation materials usually selected. The most accepted procedure is the placement of 3 cannulated screws parallel or in a triangle shape proximal of the base [11]. In displaced fractures, the most preferred fixation methods are multiple cannulated spongious screws (46%) and DHS (49%). Most orthopedists prefer closed reduction and to perform the operation within the first 8-24 hours [12].

Tükenmez et al. [13] applied multiple cannulated screws to 22 patients and DHS to 19, and there was reported to be no significant difference in respect of the outcomes. Fixation with multiple cancellous screws is a method which can still be used, especially in non-displaced fractures, and when used together with hematoma drainage, reduction as early as possible, first fully applied closed, it has been concluded that the fixation should be rigid [14]. In the current series of 49 patients, closed reduction was applied to all the patients and fixation with 3 cannulated spongious screws.

At the time of fracture, the capsule may be torn as a result of severe trauma. This mechanism will reduce intracapsular pressure and prevent venous stasis without open reduction, thereby increasing the chance of union. When the capsule is intact, capsular distension together with increased intracapsular pressure is thought to be a cause of potential post-traumatic osteonecrosis, and it can therefore be debated that hematoma aspiration during fixation or decompression with capsulotomy is useful. It has been shown that needle aspiration or hematoma decompression with capsulotomy reduces intracapsular pressure and improves blood flow in the femoral head, but it has also been reported that there is insufficient evidence to justify capsulotomy from a practical perspective [11]. After ultraound examination of intracapsular fractures, therapeutic punction of the joint and hemarthrosis drainage will reduce intracapsular pressure and it has been recommended that this is performed within 6 hours of the injury to patients who cannot be treated with osteosynthesis or that capsulotomy is performed intraoperatively before osteosynthesis [15]. Harper et al. [16] measured intracapsular and intra-articular pressure. It was determined that intraosseous pressure fell after aspiration of intracapsular fractures and it was concluded that elimination of the initial venous obstruction was associated with the removal of the intracapsular hematoma. Rawall et al. [17] stated that a greater increase in intracapsular pressure could be a strong determinant of AVN, and could therefore be an important prognostic factor. In these types of cases with a significant intracapsular pressure difference, early capsulotomy was recommended to reduce the incidence of AVN. Jain et al. [18] suggested that the rate of avascular necrosis might be higher when reduction and fixation is delayed for more than 12 hrs after a subcapital hip fracture in young adults. In a series with 7 years of clinical follow-up, Maruenda et al. [19] concluded that the vascular damage at the time of the fracture, and not the tamponade effect from the intracapsular hematoma, was associated with avascular necrosis. Dedrick et al. [20] reported that open reduction with formal capsulotomy was not related to the outcome. In the current study of 49 patients, punction (mean 28cc) was performed under preoperative aseptic conditions to 25 patients. Reduction was seen to be obtained more easily after punction. The femoral offset values were found to be lower in the group where hematoma was protected but the difference was not statistically significant. Non-union developed in 5 patients in each group, with no difference determined.

In a study by Kinik et al. [21], open capsulotomy was applied from the anterior to all 22 patients in the series, and it was reported that AVN developed in 3 patients, non-union in 2 patients, and 17 patients recovered without complications. Bulut et al. [14] reported that of 42 patients, AVN was determined in 7 (16.7%) and non-union in 3 (7.1%) in the late-term. It was stated that displacement in the initial status of the fracture had a significant effect on complications. Rawall et al. [17] measured intraoperative intracapsular pressure and reported that of 16 cases with pressure difference <30 mmHg, AVN developed in only 1 (6%) and non-union developed in 4 (25%), whereas of the 11 cases with pressure difference >30 mmHg, AVN developed in 5 (45%) and non-union developed in 4 (36%).

Some authors have determined a statistically higher incidence of non-union in fractures applied with open reduction compared to fractures stabilized with closed reduction. A higher incidence of AVN has been determined in fractures applied with closed reduction compared to those applied with open reduction, which suggests that open reduction may be better than closed reduction for decreasing the incidence of AVN [3, 22]. In the current study, AVN developed in 4 (16%) patients in Group 1 and in 1 (4.17%) patient in Group 2. Revision surgery due to other complications was applied to 7 (28%) patients in Group 1.

There were some limitations to this study, primarily the low number of patients in the groups. This study was retrospective in design. Each fracture should be evaluated individually and patient comorbidities may have affected bone union and the other parameters. Therefore, there is a need for further studies of more extensive patient series to evaluate microvascular circulation to be able to make patient-based evaluations.

Conclusion

From the results of this study, it was seen that unlike hematoma formed in extremity fractures, hematoma in femoral neck fractures has an effect that makes union difficult rather than facilitating callus formation.

Hematoma punction led to an increased risk of avascular necrosis with impaired intraosseous circulation flowing in reverse to the femoral head due to negative pressure formed in the fracture line.

References

1. Askin SR, Bryan RS. Femoral neck fractures in young adults. Clin Orthop Relat Res. 1976 Jan-Feb;(114):259-64. PMID: 1261119.
2. Robinson CM, Court-Brown CM, McQueen MM, Christie J. Hip fractures in adults younger than 50 years of age. Epidemiology and results. Clin Orthop Relat Res. 1995 Mar;(312):238-46. PMID: 7634609.
3. Damany DS, Parker MJ, Chojnowski A. Complications after intracapsular hip fractures in young adults. A meta-analysis of 18 published studies involving 564 fractures. Injury. 2005 Jan;36(1):131-41. doi: 10.1016/j.injury.2004.05.023.
4. Kregor PJ. The effect of femoral neck fractures on femoral head blood flow. Orthopedics. 1996 Dec;19(12):1031-6; quiz 1037-8. PMID: 8972521.

5. Koval KJ, Zuckerman JD. Femoral Neck Fractures. In: Koval KJ, Zuckerman JD, eds. Hip Fractures. A Practical Guide to Management. New York: Springer; 2000. pp. 49–127.
6. Soto-Hall R, Johnson LH, Johnson RA. Varıatıons In The Intra-Artıcular Pressure Of The Hıp Joınt In Injury And Dısease. A Probable Factor In: Avascular Necrosis. J Bone Joint Surg Am. 1964 Apr;46:509-16. PMID: 14131429.
7. Flynn M. A new method of reduction of fractures of the neck of the femur based on anatomical studies of the hip joint. Injury. 1974 May;5(4):309-17. PMID: 4426685.
8. Garden RS. Low-angle fixation in fractures of the femoral neck. J Bone Joint Surg (Br). 1961; 43:647-63. doi: 10.1302/0301-620X.43B4.647.
9. Pauwels F. Der Schenkelhalsbruch, ein mechanisches problem. Grundlagen des Heilungsvorganges, Prognose und Kausale Therapie. Stuttgart, Germany: Beilagenheft zur Zeitschrift fur Orthop Chirurgie.1935. pp. 64.
10. Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. J Bone Joint Surg Am. 1969 Jun;51(4):737-55. PMID: 5783851.
11. Rodríguez-Merchán EC. In situ fixation of nondisplaced intracapsular fractures of the proximal femur. Clin Orthop Relat Res. 2002 Jun;(399):42-51. PMID: 12011693.
12. Slobogean GP, Sprague SA, Scott T, McKee M, Bhandari M. Management of young femoral neck fractures: is there a consensus? Injury. 2015 Mar;46(3):435-40. doi: 10.1016/j.injury.2014.11.028.
13. Tükenmez M, Çekin T, Perçin S, Tezeren G. Femur Boyun Kırıklarında İnternal Fiksasyon. CÜ Tıp Fakültesi Dergisi. 2004;26(3):131-5.
14. Bulut O, Tükenmez M, Demirel H, Çekin T. Erişkin femur boyun kırıklarında multipl kansellöz vida fiksasyonu. Eklem Hastalıkları ve Cerrahisi. 2004;15(4):183-7.
15. Bonnaire F, Schaefer DJ, Kuner EH. Hemarthrosis and hip joint pressure in femoral neck fractures. Clin Orthop Relat Res. 1998 Aug;(353):148-55. doi: 10.1097/00003086-199808000-00017.
16. Harper WM, Barnes MR, Gregg PJ. Femoral head blood flow in femoral neck fractures. An analysis using intra-osseous pressure measurement. J Bone Joint Surg Br. 1991 Jan;73(1):73-5. doi: 10.1302/0301-620X.73B1.1991780.
17. Rawall S, Bali K, Upendra B, Garg B, Yadav CS, Jayaswal A. Displaced femoral neck fractures in the young: significance of posterior comminution and raised intracapsular pressure. Arch Orthop Trauma Surg. 2012 Jan;132(1):73-9. doi: 10.1007/s00402-011-1395-1.
18. Jain R, Koo M, Kreder HJ, Schemitsch EH, Davey JR, Mahomed NN. Comparison of early and delayed fixation of subcapital hip fractures in patients sixty years of age or less. J Bone Joint Surg Am. 2002 Sep;84(9):1605-12. doi: 10.2106/00004623-200209000-00013.
19. Maruenda JI, Barrios C, Gomar-Sancho F. Intracapsular hip pressure after femoral neck fracture. Clin Orthop Relat Res. 1997 Jul;(340):172-80. doi: 10.1097/00003086-199707000-00022.
20. Dedrick DK, Mackenzie JR, Burney RE. Complications of femoral neck fracture in young adults. J Trauma. 1986 Oct;26(10):932-7. doi: 10.1097/00005373-198610000-00013.
21. Kinik H, Polat O, Mergen E. Femoral neck fractures treated with cannulated screw. Acta Orthopaedica et Traumatologica Turcica. 2006; 33(1):13-17.
22. Zetterberg CH, Irstam L, Andersson GB. Femoral neck fractures in young adults. Acta Orthop Scand. 1982 Jun;53(3):427-35. doi: 10.3109/17453678208992237.

This paper has been checked for language accuracy by JOSAM editors.
The National Library of Medicine (NLM) citation style guide has been used in this paper.