

## Original Article

### Determinants of Early Complications in Femur Neck Fractures Following Operative Management in a Resource Limited Setting : A Facility Based Retrospective Study

Teshome Tena<sup>1</sup>, Mengistu G Mengesha<sup>2</sup>, Gabriel Alemayehu<sup>3</sup>, Samuel Hailu<sup>1</sup>

<sup>1</sup>Addis Ababa University, Tikur Anbessa Specialized Hospital, Department of Orthopedic

<sup>2</sup>Hawassa University, College of Medicine and Health Science, Department of Orthopedics

<sup>3</sup>Washington State University, College of Medicine

Corresponding authors\*: teshomet24@gmail.com

#### Abstract

**Introduction:** The main goal of treating femoral neck fractures in young patients and non-displaced fractures in the elderly is preserving the femoral head while reducing complications. The aim of the study was to assess factors determining early complications after fixation of femur neck fracture.

**Methods and Materials:** This was a three-years retrospective study conducted at tertiary at Tikur Anbessa Specialized Hospital were reviewed. Data was analysed using SPSS version 29 and results were summarized by text and table. Bivariate and multivariate analysis were used to assess the association between explanatory and outcome variables. Factors with  $P$ -value  $<0.05$  in the multivariate analysis were considered to have statistically significant association with outcome.

**Results:** A total of 78 patients were included where 57 (73%) patients were male and mean age was 37 years. The average time from injury to surgery was 17.8 days; more than two third of patients were operated on after 07 days of the injury. Sixty-seven (85.9%) were displaced and 9 were classified as Pauwels type III (angle  $>70^\circ$ ). There were 22(28.2%) non-acceptable fracture reductions according to Garden alignment index. Twenty-nine (37.2%) patients had developed complications where fixation failure was commonest occurring in 20(25.4%) followed by non-union 6(7.7%) and AVN 3(3.8%). From the multivariate analysis, patients who had unacceptable garden alignment index were significantly associated with early complications (AOR - 27.43; 95%CI 5.62-133.95,  $p<0.001$ ), while the presence of revision was marginally associated with early complications (AOR- 21.7, 95% CI 0.69-1000,  $p=0.079$ ).

**Conclusion:** In fixation of femur neck fracture, achieving anatomic reduction, assessed via the immediate postoperative Garden alignment index, predominantly influences early complications. Time from injury to surgery doesn't significantly impact early outcomes, suggesting operability beyond 7 days in resource-limited settings.

**Keywords:** Risk factors, Femur neck fracture, Early complications, Garden Alignment index, Ethiopia

**Citation :** Tena T, Mengesha MG, Alemayehu G, Samuel H, Determinants of Early Complications In Femur Neck Fractures Following Operative Management in a Resource Limited Setting: A Facility Based Retrospective Study. Ethiop Med J 62 (supplement 1) 119-126

**Submission date :** 29 December 2023 **Accepted:** 9 February 2024 **Published:** April, 2024

#### Introduction

The main goal of treating femoral neck fractures in young patients and non-displaced fractures in elderly is preserving the femoral head while reducing complications (1,2). A surgically treated femoral neck fracture typically undergoes healing within three to five months (3). However, Complication rates such as early fixation loss, non-union, and avascular necrosis (AVN) of the femoral head, range from 10% to 45% (4,5). Thirty-three percent of patients undergoing internal fixation require reoperation, while one in seven necessitate conversion to total hip replace-

ment (THR) (6). Patient physiology, fracture specifics, fixation quality, and rehabilitation influence healing. Delays  $> 24$  hours in fixation, and comorbidities (smoking, alcohol, renal issues) predict potential fixation failure (7). Similarly, Displaced fracture, unacceptable reduction, high Pauwels angle, and posterior cortex comminution are risk factors for non-union and implant failure (8,9).

According to Upadhyay A et al randomized control trial done on displaced fractures, the efficacy of internal fixation within one week of injury is consistent (8).

Internal fixation within 6 hours post-injury shows lower rates of non-union and avascular necrosis (AVN) compared to fixation between 6 to 24 hours and beyond 24 hours. However, discrepancies exist regarding the optimal timing for operative intervention to prevent non-union (9, 10).

Intervention after one week of injury interferes with anatomic reduction due to fibrosis formation around the fracture and proximal migration of the distal fragment that necessitate open procedures (8). In low and middle-income countries (LMIC), there is a delay in presentation to healthcare facilities and delivery of treatment which is true for femur neck fracture fixation as well (10).

To our knowledge, in LMIC, there is no data on the outcomes of femur neck fixation and determinants of early complications. This study primary aim is to identify the factors influencing early complications within 6 months of fixation mainly fixation failure and AVN, and non-union.

## Methods and Materials

### Study Setting, Design and Period

This is a retrospective study done at a tertiary institution in Addis Ababa, Tikur Anbessa Specialized Hospital (TASH) between January 2020 and December 2022. The Department of Orthopedics at TASH was established in 1987. It has 75 beds in the adult and paediatric orthopedic wards where trauma patients account 61.5% of admissions.

### Study participants

All patient who underwent femur neck fracture fixa-

tion during the study period was included in the study.

### Study Variables

The outcome of femur neck fracture fixation like implant failure, non-union and AVN were dependant variables while the rest including socio-demographic variables such as age, sex, clinical and radiologic characteristics were independent variables.

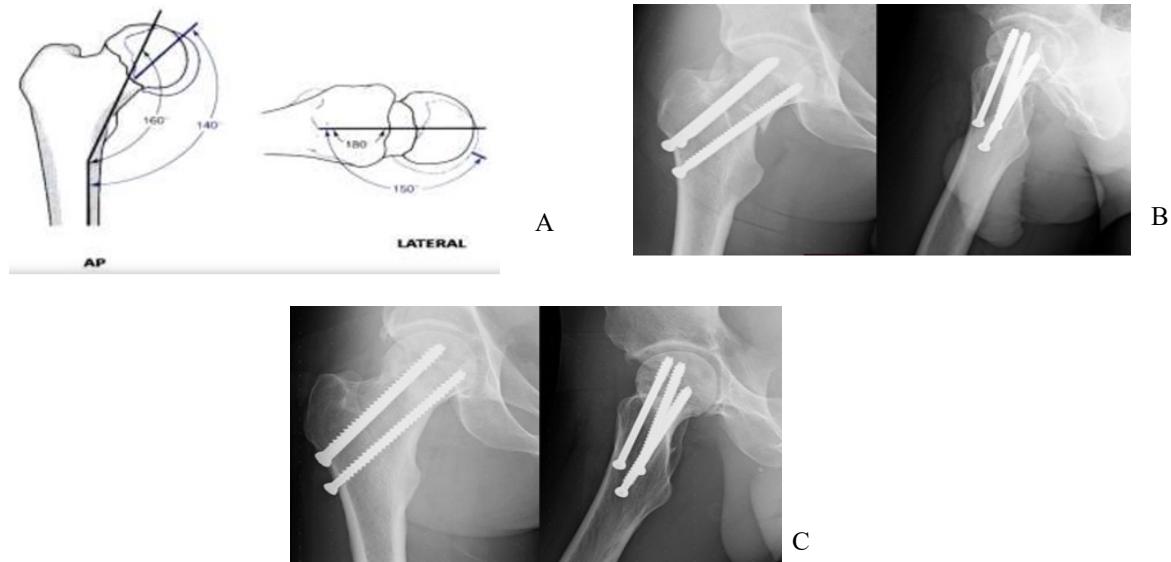
### Inclusion and exclusion criteria

Patients with a complete medical record, and with a minimum of six-month follow-up were included In the study. Patients with bullet injuries, pathologic fractures, and incomplete data were excluded.

### Operational definition and technique

Preoperatively, patients underwent antero-posterior and lateral hip X-rays, deep venous thrombosis screening done for patients who come after 48 hours of injury, and received prophylaxis. Surgeries were performed by orthopedic trauma specialists or fellows. Patients were positioned supine on a traction or standard table, attempting closed reduction; open approaches were used if needed. Intraoperative fluoroscopy verified reduction, employing either three parallel canulated hip screws or dynamic hip screws for fixation.

The quality of reduction was evaluated using the Garden Alignment Index (GAI) in immediate postoperative x-rays. Acceptable alignment ranged between 155 to 180 degrees, measured as the angle of the compression trabeculae concerning the medial femoral shaft on anteroposterior and lateral views (Fig 1)



**Fig. 1** a) Garden Alignment Index Measurement b) Postoperative AP and lateral radiography with acceptable GAI. Surgery was done 21 days after injury c) AP/Latera radiography at 2 years

Postoperatively, patients were followed at 2, 6, and 12 weeks; then biannually with physical examinations and radiology. Weight-bearing is allowed at 12 weeks or upon evidence of clinical and radiological union. Complications were managed promptly.

**Fixation failure** was defined as osteofixation loss and fracture displacement within 6 months of surgery via radiography.

**Non-union** was defined as persistent pain and radiolucent line at 6 months post-fixation.

**AVN** defined as femoral head collapse post-fracture healing on X-ray. Because of short follow up period and magnetic resonance imaging (MRI) there may be missed cases.

**Early complication** is defined as the presence of fixation failure, AVN, and/or non-union within 6 months of postoperative follow-up.

#### **Data collection and Analysis**

The data was collected with Excel which was exported into SPSS version 29 for data cleaning and analysis. The result was summarized by using texts, tables, and figures. The data was presented with mean and median for continuous and proportion for categorical variables. Bivariate and multivariate analysis was used to assess the association between explanatory and outcome variables which is early complications within 6 months of the operation and statistically significant was declared when the P-value was  $<0.05$  in the multivariate analysis.

#### **Ethical Consideration**

The study was conducted after getting Ethical approval from Addis Ababa University College of Health Sciences with institutional review board number AAUMF 03-008.

#### **Result**

Sociodemographic characteristics of patients. A total of 357 femur neck fracture patients' data was recorded from January 2020 to December 2022 where 104 patients underwent femur neck fixation. Seventy-eight patients with femur neck fractures were included in our study. The excluded patients included those with incomplete data (13), bullet injury (9), young age less than 18 years (3), one pathologic fracture, and patients underwent replacement surgery.

Fifty-seven (73%) patients were male and the mean age at the time of surgery was 37 (18 -75) while the median age was 35 years. Road traffic accident (RTA) was the commonest mechanism of injury for 31(39.7%) patients, followed by fall from height in 24 (30.7%). Only 7(9%) patients had comorbidity where smoking was commonest 3(3.8%). Thirteen (17%) patients had associated other musculoskeletal injuries

The average time from injury to the date of surgery was 17.8 (1 - 126) days; whereas the median time of injury to surgery was 13.5. One patient operated at 126 day of injury. More than two-thirds of patients were operated after 07 days of the injury.

Among the 78 femur neck fractures, 67 (85.9%) were displaced and 9 were classified as modified Pauwels type III (angle  $>70^\circ$ ).

Closed reduction was successful for 48(61.5%) fractures where cannulated hip screw was used for 67 (85.9%) fractures fixation. There were 22(28.2%) non-acceptable fracture reductions according to Garden alignment index. Immediate post-operative revision surgery was performed for 7(9%) patients for indication of unacceptable reduction, and screw penetrations (**Table 1**).

#### Six month's Outcome data

Twenty-nine (37.2%) patients had developed complications where fixation failure was commonest occurring in 20(25.4%) followed by non-union 6(7.7%) and AVN 3(3.8%) (**Table 1**).

Displaced fractures, modified Pauwels type III, unacceptable garden alignment index, and need for immediate postoperative revision were found to be determinants for the development of early complications on the bivariate analysis (**Table 2**).

Among 67 patients with displaced fractures, 28 (41.8%) developed complications. Based on the modified Pauwels classification, 9 were type III where 6 (67.7%) developed complications.

Of the 22 (28.2%) patients with unacceptable reduction, 20(90.1%) of them developed complications. Closed reduction is successful for 48 of these 15 developed complication and 30 patients under went open reduction of these 14 developed complications (**Table 2**).

**Table 1.** Sociodemographic and radiologic status of femur neck fracture patients

Variables		Frequency No. (%)
Age(years)	≤40	48 (61.5)
	>40	30(38.5)
Sex	Male	57(73)
	Female	21 (27)
Location	AA(Addis Ababa)	33(43.3)
	OAA(outside Addis Ababa)	45(57.7)
Comorbidity	None	71(91)
	Had comorbidity	7(9)
Mechanism of injury	RTA	31(39.7)
	Fall-height	24(30.7)
	Fall-standing	23(29.6)
Injury to surgery time(days) (Average 17.8)	≤ 7 days	23(29.5)
	>7 days	55(70.5)
Garden (n= 79)	Non-displaced (I&II)	11(14.1)
	Displaced (III & IV)	67(85.9)
Pauwels (Original)*	I & II (<50 °)	23 (29.5)
	III (>50 °)	55 (70.5)
Pauwels (modified)**	I & II (<70 °)	69(88.5)
	III (≥70°)	9(11.5)
Fixation methods	CHS	67(85.9)
	DHS	11(14.1)
Garden alignment index	Acceptable	56(71.8)
	Non-acceptable	22(28.2)
Use of fully threaded screws	Used	44(65.2)
	Not used	23(34.8)
Presence of complications	Yes	29 (37.2)
	No	49(62.8)
Types of complications	Fixation Failure	20(25.4)
	Non-union	6(7.7)
	AVN	3(3.8)

\*Represented the Pauwels classification where Pauwels type III is the angle measurement greater than 50 degrees.

\*\* Represented the Pauwels classification where Pauwels type III is the angle measurement greater than 70 degrees.

**Table 2.** Showing the association between sociodemographic status and complications

Variables	Complications No. (%)		P-value
	No	Yes	
Age	≤40	34 (70.8)	0.064
	>40	15 (50)	
Sex	Male	38 (66.7)	0.843
	Female	11 (52.4)	
Location	AA	23 (69.7)	0.282
	OAA	26 (57.8)	
Comorbidity	None	46 (64.8)	0.252
	Had	3 (42.9)	
Mechanism of injury	RTA	21 (70)	0.408
	Fall from height	16 (64)	
Injury to time of surgery	Fall from ground	12 (52.2)	
	≤ 7 days	17 (73.9)	0.19
	7 days	32 (58.2)	
Garden type	Non-displaced	10 (90.9)	0.038
	Displaced	39 (58.2)	
Pauwels type (Original)	I&III (<50 °)	18 (78.3)	0.068
	III >50 °	31 (56.4)	
Pauwels type (modified)	I&II (<70 °)	46 (66.7)	0.052
	III (≥70°)	3 (33.3)	
Reduction method	Closed	33 (68.8)	0.17
	Open	16 (53.3)	
Garden alignment index	Acceptable	47 (83.9)	0.001
	Nonacceptable	2 (9.1)	
Revision	Yes	1 (14.3)	0.005
	No	48 (67.6)	
Use of fully threaded	Yes	27 (62.8)	0.878
	No	14 (60.9)	

From the multivariate analysis, patients who had unacceptable garden alignment index was significantly associated with early complications (AOR - 27.43; 95%CI 5.62-133.95,  $p<0.001$ ). But the presence of revision was modestly associated with early complications (AOR 21.7; 0.69-1000,  $p=0.079$  (**Table 3**))

## Discussion

In our study, 37.2% patients developed overall early complications. This is comparable with study done by Duckworth 32% (7), Stappaerts in Belgium 32.5% (11). We found that non-acceptable Garden alignment index is statically significant risk factor for early complications whereas, immediate post-operative revision surgery is modest risk factor. Similar to our finding, early complications observed in femur neck fixations with non-acceptable Garden alignment index (11-13). Previous studies in the literature shows anatomic reduction and stable fixation prevent bad results in femur neck fracture fixation (14-16)

In our series median time of surgery was 13.5 days; as the patients present delayed and limited resources for timely treatment. We didn't find any associa-

tion between time of surgery and early complications. This result is supported by multicentre study done in Malaysia on outcome of femur neck fixation in young patients shows 50% complications; AVN (32%), non-union(11%) and infection 4.3% where; time of surgery had not association with complications(14). Due to short follow up period unlike other studies (2, 17) the percentage of AVN in our study is low. Another meta-analysis done on effect of timing of internal fixation of intra-capsular femur neck fixation on late development of AVN & non-union failed to show any association (18). In contrary to this fixation within 6 hours of injury shows less non-union and AVN compared to 6 to 24 and after 24 hours (19).

We have found a significantly higher complication (28.2%,  $P=0.038$ ) in displaced fractures compared to non-displaced fractures, similar to the study by Roger Erivan et al HR = 2.77 (95%CI: 1.09–7.02),  $p = 0.025$  (20) and Yang et al OR=2.93 (95%CI: 1.08-7.96),  $P=0.035$  (21). Another study done in Norway by Hoelsbrekken et al shows 26.8 % fixation failure, non-union, and AVN rate in displaced fractures, while it is 10.3 % in non-displaced (22).

**Table. 3** Bivariate and Multivariate modelling showing the association between explanatory and outcome variables (early complications)

Variables	Bivariate Analysis		Multivariate analysis	
	OR (95% CI)	P-value	AOR (95%CI)	P value
Age (Ref: ≤ 40) > 40	2.06(0.79-5.39)	0.14	2.36 (0.53-10.46)	0.257
Time to Surgery (Ref: ≤ 7 days) >7 days	3.17(9.95-10.57)	0.06	1.36 (0.24-7.66)	0.727
Garden Type (Ref: I&II) III&IV	595(0.72-49.31)	0.10	5.14 (0.35-75.74)	0.233
Pauwels Type (Ref: I&II) III	2.86(0.7-11.71)	0.15	1.39 (0.12-16.93)	0.794
Reduction Method (Ref: Closed) Open	2.06(0.79-5.39)	0.14	1.41 (0.29-7.00)	0.671
Garden alignment index (Ref: Acceptable) Non-acceptable	44.33(10.37-189.48)		27.43 (5.62-133.95)	<.001
Revision (Reference -No) Yes	15.3(1.73-135.25)	<0.001		0.079
		0.014	21.7(0.69-1000)	

However, a result of logistic regression analysis could not find the presence of displacement as a factor predicting the complication comparable to a study by Ramadanan et al (23).

It is indicated that age is a predictive factor for femoral head necrosis (23, 24). However, we could not find any significant difference in age between the patients with complications such as fixation failure, non-union, and femoral head necrosis and those without complications. This is in line with a study by Yang et al which shows age has no association with non-union (21).

Pauwels' original thesis suggested, that the more vertical the Pauwels angle is, the higher the incidence of non-union (25). However, the findings in the study of Parker and Dynan, which was conducted among 335 patients, failed to find any correlation between the Pauwels angle and non-union in both displaced and undisplaced fractures (26). In our series, there is a higher tendency of early complications in Pauwels type III fractures with an angle greater than 70 degrees.

### Conclusion

Our study shows that unacceptable Garden alignment index and immediate post-operative revision surgery were the main risk factors for early complications.

### Recommendations

Based on our findings, we recommend anatomic reduction irrespective of the time of injury to surgery is

a key consideration during femur neck fracture fixation. Further study on late complication with long term follow up and comparative outcome study on early and late femur neck fracture fixation.

### Conflict of Interest

There is no conflict of interest to declare.

### Abbreviations and Acronym

AA	Addis Ababa
AAU	Addis Ababa University
AVN	Avascular Necrosis
DHS	Dynamic hip screw
LMIC	Low and Middle Income Country
OAA	Outside Addis Ababa
RTA	Road Traffic Accident
TASH	Tikur Anbessa Specialized Hospital

### Acknowledgment:

We would like to acknowledge Tikur Anbessa Specialized Hospital for providing the necessary resources and facilities that enabled us to conduct this study. We extend our appreciation to our colleagues.

## References

- Gautam VK, Anand S, Dhaon BK. Management of displaced femoral neck fractures in young adults (a group at risk). *Injury*. 1998;29(3):215–8.
- Pauyo T, Drager J, Albers A, Harvey EJ. Management of femoral neck fractures in the young patient: A critical analysis review. *World journal of orthopedics*. 2014;5(3):204.
- Alberts KA, Dahlborn M, Ringertz H. Sequential scintimetry after femoral neck fracture: Methodologic aspects and prediction of healing complications. *Acta Orthopaedica Scandinavica*. 1987 Jan;58(3):217–22.
- Davidovitch RI, Jordan CJ, Egol KA, Vrahlas MS. Challenges in the treatment of femoral neck fractures in the nonelderly adult. *J Trauma*. 2010 Jan;68(1):236–42.
- Bhandari M, Tornetta P, Hanson B, Swiontkowski MF. Optimal internal fixation for femoral neck fractures: multiple screws or sliding hip screws? *J Orthop Trauma*. 2009 Jul;23(6):403–7.
- Stockton DJ, O'Hara LM, O'Hara NN, Lefaivre KA, O'Brien PJ, Slobogean GP. High rate of reoperation and conversion to total hip arthroplasty after internal fixation of young femoral neck fractures: a population-based study of 796 patients. *Acta Orthop*. 2019 Feb;90(1):21–5.
- Duckworth AD, Bennet SJ, Aderinto J, Keating JF. Fixation of intracapsular fractures of the femoral neck in young patients: risk factors for failure. *The Journal of Bone and Joint Surgery British volume*. 2011;93(6):811–6.
- Upadhyay A, Jain P, Mishra P, Maini L, Gautam VK, Dhaon BK. Delayed internal fixation of fractures of the neck of the femur in young adults: a prospective, randomised study comparing closed and open reduction. *The Journal of bone and joint surgery British volume*. 2004;86(7):1035–40.
- Liporace F, Gaines R, Collinge C, Haidukewych GJ. Results of Internal Fixation of Pauwels Type-3 Vertical Femoral Neck Fractures: The Journal of Bone and Joint Surgery-American Volume. 2008 Aug;90(8):1654–9.
- Whitaker J, O'Donohoe N, Denning M, Poenaru D, Guadagno E, Leather AJM, et al. Assessing trauma care systems in low-income and middle-income countries: a systematic review and evidence synthesis mapping the Three Delays framework to injury health system assessments. *BMJ Global Health*. 2021 May 1;6(5):e004324.
- Wamisho BL, Zewde W. Major orthopaedic procedures: 17 Year Trends. *East Cent Afr J Surg*. 2006;11(1):32–
- Stappaerts KH. Early fixation failure in displaced femoral neck fractures. *Arch Orthop Trauma Surg* (1978). 1985;104(5):314–8.
- Garden RS. MALREDUCTION AND AVASCULAR NECROSIS IN SUBCAPITAL FRACTURES OF THE FEMUR. *The Journal of Bone & Joint Surgery British Volume*. 1971 May 1;53-B(2):183–97.
- Ehlinger M, Favreau H, Eichler D, Adam P, Bonnomet F. Early mechanical complications following fixation of proximal femur fractures: From prevention to treatment. *Orthopaedics & Traumatology: Surgery & Research*. 2020 Feb 1;106(1, Supplement):S79–87.
- Raj JJ, Kow RY, Ganthel@Annamalai K, Kunasingh DE, Panicker GK, Lim BC, et al. Outcomes of Femoral Neck Fractures in Young Patients and the Factors Associated With Complications: A Multicenter Study From Malaysia. *Cureus* [Internet]. 2021 Sep 19 [cited 2022 Oct 26];13(9). Available from: <https://www.cureus.com/articles/65834-outcomes-of-femoral-neck-fractures-in-young-patients-and-the-factors-associated-with-complications-a-multicenter-study-from-malaysia>
- Chua D, Jaglal SB, Schatzker J. Predictors of early failure of fixation in the treatment of displaced subcapital hip fractures. *J Orthop Trauma*. 1998 May;12(4):230–4.
- Medda S, Snoap T, Carroll EA. Treatment of Young Femoral Neck Fractures. *Journal of Orthopaedic Trauma*. 2019 Jan;33:S1.
- Haidukewych GJ, Rothwell WS, Jacofsky DJ, Torchia ME, Berry DJ. Operative treatment of femoral neck fractures in patients between the ages of fifteen and fifty years. *J Bone Joint Surg Am*. 2004 Aug;86(8):1711–6.
- Papakostidis C, Panagiotopoulos A, Piccioli A, Giannoudis PV. Timing of internal fixation of femoral neck fractures. A systematic review and meta-analysis of the final outcome. *Injury*. 2015;46(3):459–66.
- Manninger J, Kazar G, Fekete G, Fekete K, Frenyo S, Gyarfas F, et al. Significance of urgent (within 6 h) internal fixation in the management of fractures of the neck of the femur. *Injury*. 1989 Mar;20(2):101–5.
- Eriyan R, Fassot G, Villatte G, Mulliez A, Descamps S, Boisgard S. Results of femoral neck screw fixation in 112 under 65-years-old at a minimum 2 years' follow-up. *Orthopaedics & Traumatology: Surgery & Research*. 2020;106(7):1425–31.
- Yang JJ, Lin LC, Chao KH, Chuang SY, Wu CC, Yeh TT, et al. Risk factors for nonunion in patients with intracapsular femoral neck fractures treated with three cannulated screws placed in either a triangle or an inverted triangle configuration. *JBJS*. 2013;95(1):61–9.
- Hoelsbrekken SE, Opsahl JH, Stiris M, Paulsrød Ø, Strømsøe K. Failed internal fixation of femoral neck fractures. *Tidsskrift for Den norske legeforening*. 2012;

24. Ramadanov N, Toma I, Herkner H, Klein R, Behringer W, Matthes G. Factors that influence the complications and outcomes of femoral neck fractures treated by cannulated screw fixation. *Scientific reports*. 2020;10(1):1–7.
25. Schweitzer D, Melero P, Zylberberg A, Salabarrieta J, Urrutia J. Factors associated with avascular necrosis of the femoral head and nonunion in patients younger than 65 years with displaced femoral neck fractures treated with reduction and internal fixation. *Eur J Orthop Surg Traumatol*. 2013 Jan;23(1):61–5.
26. Nowakowski AM, Ochsner PE, Majewski M. Classification of femoral neck fractures according to pauwels: interpretation and confusion —Reinterpretation: a simplified classification based on mechanical considerations. *JBiSE*. 2010;03(06):638–43.
27. Parker MJ, Dynan Y. Is Pauwels classification still valid? *Injury*. 1998 Sep;29(7):521–3.