Posterior Tilt Angle Prognostic Value for Nondisplaced Femoral Neck Fractures

Efstratios Papadelis, Yash Chaudhry, Hunter Hayes, Christopher Talone, Mitesh Shah

INTRODUCTION:

Recent literature indicates the rate of revision surgery following internal fixation of Garden I and II fractures is approximately 20%. Historically the Garden Classification has been used to guide treatment of femoral neck fractures. Originally proposed by Palm et al, Posterior Tilt Angle is a radiographic measurement that evaluates the severity of angulation at the site of femoral neck fracture. This systematic review and meta-analysis aimed to evaluate the posterior tilt angle in predicting treatment failure after internal fixation of nondisplaced femoral neck fractures as graded by the Garden classification, which is based solely on anterior-posterior radiographic evaluation.

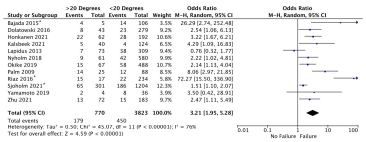
METHODS: This systematic review was conducted following PRISMA guidelines. Quality appraisal was conducted using the MINORS criteria and all data from the included studies was manually extracted and summarized. Outcomes of interest included development of malunion, nonunion, avascular necrosis, loss of fixation, and reoperation requirement. A full text review of 40 studies was conducted after inclusion and exclusion criteria were applied and a total of 17 studies were included in the systematic review.

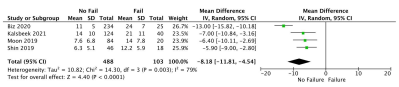
RESULTS: Treatment failure was observed in 14% of cases. Posterior Tilt Angle ≥20° had a failure rate of 24%, compared to 12% for <20° ($p<0.001$). Among studies reporting continuous values for posterior tilt angle, those with failure were found to have 8.2° larger posterior tilt angle ($p=0.003$).

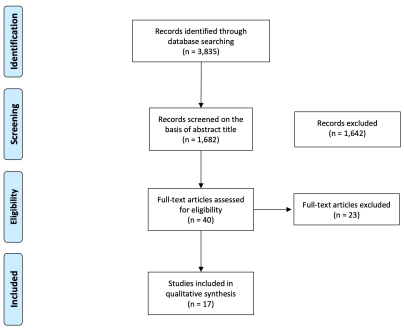
DISCUSSION AND CONCLUSION: Several studies have demonstrated high inter- and intra-observer reliability of the posterior tilt angle measurement method described by Palm et. al., which relies on appreciating the cortical lines of the femoral head and neck. If adequate lateral radiographs to measure the posterior tilt are difficult to obtain, augmenting the workup with a computed tomography scan and assessing axial cuts has been shown to be an effective alternative. This was defined as the “retroversion angle” by Shin et. al., which provides a similar assessment to posterior tilt angle seen on lateral radiographs, demonstrating a 0.961 inter-observer correlation coefficient.

Nielsen et. al. conducted a systematic review of nondisplaced femoral neck fractures treated by internal fixation as well and found similar results, with a 25 percent risk of reoperation in cases involving a posterior tilt angle ≥20 degrees as opposed to 10 percent for cases with posterior tilt angle < 20 degrees. Their review only considered reoperation risk, whereas the current study assessed treatment failure as a whole, including nonunion, malunion, avascular necrosis, fixation failure, or requirement for reoperation, which more thoroughly describes the morbidity involved in this intervention. Furthermore, the Nielsen et. al. study did not examine studies reporting posterior tilt angle in a continuous manner, choosing only to include studies reporting outcomes based on a posterior tilt angle cutoff value of 20 degrees. In another systematic review of nondisplaced femoral neck fractures treated with internal fixation, van der List et. al. found similar results to our study, demonstrating a 6.6-fold increased odds of treatment failure for posterior tilt angle ≥20, however they had a very wide confidence interval ranging from 2.2-15.9. Additionally, they did not include four papers published in the last calendar year which amounted to 2,205 cases, almost two-thirds of the total cases included in our meta-analysis for the posterior tilt angle cutoff at 20 degrees. An important aspect of this update to the current literature on nondisplaced femoral neck fractures is the establishment of narrow confidence intervals so we can accurately understand the effect of posterior tilt angle on patient outcomes.

The results of this systematic review and meta-analysis provide strong evidence that patients undergoing internal fixation with a posterior tilt angle ≥20 degrees are at a higher risk for treatment failure. Further study, particularly with continuous data, is warranted to determine the ideal cut-off point for posterior tilt angle at which a treatment alternative such as arthroplasty should be considered. Assessment of the femoral neck tilt should be a routine practice for all femoral neck fractures and Garden I and II in particular.


>20 Degrees
<20 Degrees
Odds Ratio
Odds Ratio
Study or Subgroup Events Total Events Total Weight M-H, Random, 95% CI
M-H, Random, 95% CI
Bajada 2015* 4 5 14 106 3.5% 26.29 [2.74, 252.48]
Dolanowski 2016 8 43 23 279 9.2% 2.54 [1.06, 6.13]
Honkanen 2021 22 62 28 192 10.6% 3.22 [1.67, 6.21]
Kalisiewicz 2021 5 40 4 124 6.5% 4.29 [1.09, 16.83]
Lapidus 2013 7 73 38 109 9.4% 0.76 [0.32, 1.77]
Nyholm 2018 9 61 42 580 9.9% 2.22 [1.02, 4.81]
Okike 2019 15 67 58 488 10.7% 2.14 [1.13, 4.04]
Palm 2009 14 25 12 88 8.5% 8.06 [2.97, 21.85]
Riaz 2016* 15 17 22 234 5.8% 72.27 [15.50, 336.90]
Sjahalm 2017* 65 301 186 1294 12.3% 1.51 [1.10, 2.07]
Yamamoto 2019 2 4 8 36 3.9% 3.50 [0.42, 28.91]
Zhu 2021 13 72 15 185 9.7% 2.47 [1.11, 5.49]
Total (95% CI) 770 3823 100.0% 3.21 [1.91, 5.28]
Total events 179 450
Heterogeneity: Tau² = 0.50; Chi² = 45.07, df = 11 (P < 0.00001); I² = 76%
Test for overall effect: Z = 4.59 (P < 0.00001)
0.01 0.1 1 10 100
No Failure Failure


No Fail
Fail
Mean Difference
Mean Difference
Study or Subgroup Mean SD Total Mean SD Total Weight IV, Random, 95% CI
IV, Random, 95% CI
Biz 2020 11 5 234 24 7 25 26.7% −13.00 [−15.82, −10.18]
Kalisiewicz 2021 14 10 124 21 11 40 23.5% −7.00 [−10.84, −3.16]
Moon 2019 7.6 6.8 84 14 7.8 20 23.9% −6.40 [−10.11, −2.69]
Shin 2019 6.3 5.1 46 12.2 5.9 18 25.9% −5.90 [−9.00, −2.80]
Total (95% CI) 488 103 100.0% −8.18 [−11.81, −4.54]
Heterogeneity: Tau² = 10.82; Chi² = 14.30, df = 3 (P = 0.003); I² = 79%
Test for overall effect: Z = 4.40 (P < 0.0001)
−20 −10 0 10 20
No Failure Failure


Identification
Screening
Eligibility
Included
Records identified through database searching (n = 3,835)
Records screened on the basis of abstract title (n = 1,682)
Records excluded (n = 1,642)
Full-text articles assessed for eligibility (n = 40)
Full-text articles excluded (n = 23)
Studies included in qualitative synthesis (n = 17)