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## Literature Review

### Open Reduction versus Closed Reduction with Internal Fixation for Femoral Neck Fracture: A Systematic Review and Meta-Analysis

Harvy Harvyandani<sup>1</sup>, Muhammad Tholhah Azam<sup>1</sup>, Farizky Jati Ananto<sup>1</sup>, Probo Yudha Pratama Putra<sup>1</sup>

<sup>1</sup>General Practitioner, Medical Faculty University of Muhammadiyah Malang, Malang, Indonesia

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##### Corresponding Author :

Harvy Harvyandani, MD

E-mail: [vandhani79@gmail.com](mailto:vandhani79@gmail.com)

#### Abstract

##### Introduction & Objective:

A femoral neck fracture is a fracture that has many complications which are quite dangerous. Complications often include avascular necrosis, osteonecrosis, non-union fractures, and coxa-vara. However, until now, the management of femoral neck fractures is still controversial, using the ORIF or CRIF methods. This meta-analysis aims to compare the occurrence of postoperative non-union, malunion (coxa-vara), and avascular necrosis between ORIF and CRIF.

##### Material & Method:

A systematic review was done according to the PRISMA guideline diagram and flowchart; a literature review was conducted in May 2023 using PubMed, Science Direct, Cochrane Library, Google Scholar, and Biomedcentral (BMC) —minimum publishing year 20 years. The meta-analysis procedure was carried out and processed using the RevMan V.5.3 program.

##### Result:

A total of 203 ORIF cases and 396 CRIF cases from the results of 7 studies. There was a significant difference in the incidence of union (RR 0.44, 95% CI 0.22 to 0.86,  $p = 0.02$ ) as well as the incidence of malunion (coxa-vara) there was a significant difference (RR 0.13, 95% CI 0.02 to 0.73,  $p = 0.02$ ). Whereas in the event of avascular necrosis (AVN), there was no significant difference OR 1.06, 95% CI 0.49 to 2.29,  $p = 0.08$ .

##### Conclusion:

ORIF has better effectiveness and safety than CRIF regarding the number of postoperative non-union and malunion (coxa-vara) events.

#### Introduction

A femoral neck fracture is a fracture that has many complications which are quite dangerous.<sup>1</sup> Femoral neck fractures often occur with age.<sup>2</sup> Complications often arise, including avascular necrosis, osteonecrosis non-union fractures, and coxa-vara. Where this complication usually occurs in adolescents and young adults. Other complications are infections after surgery, DVT (deep vein thrombosis), fat embolism, and urinary tract infections.<sup>3,4</sup>

Despite advances in surgery to treat femoral neck fractures, the risk of AVN and non-union after internal fixation has not changed much in the last 50 years.<sup>5</sup>

Internal fixation is one of the leading options in managing femoral neck fractures.<sup>6</sup> Among them are Open Reduction Internal Fixation (ORIF) and Closed Reduction Internal Fixation (CRIF), each of which has advantages and disadvantages (Wang Meta). Although ORIF has advantages in the appearance and restoration of normal function, its implementation is still limited because there are disadvantages in nerve damage, swelling, incomplete bone healing, and compartment syndrome.

Meanwhile, CRIF can avoid injury to the medial circumflex artery.<sup>7</sup> However, it has the disadvantage of increasing intracapsular pressure, which results in circulation to the arteries of the femoral head,

prolonged extension with an internal rotation position, and circulation to the femoral head that is not smooth, which over time results in avascular necrosis.<sup>8</sup> The type and severity of complications are known to vary in parts of the world.<sup>9,10</sup>

Therefore, the management of femoral neck fractures is still controversial. This meta-analysis aims to compare the occurrence of postoperative non-union, malunion (coxa-vara), and avascular necrosis between ORIF and CRIF.

## Material & Method

A systematic review was done according to PRISMA guideline flowcharts and diagrams; a literature review was conducted in May 2023 using PubMed, Science Direct, Cochrane Library, Google Scholar, and Biomedcentral (BMC).<sup>16</sup> The search database is limited to English, and the year of publication is at least 20 years. The search used the terms: Femoral Neck Fracture, Open Reduction Internal Fixation (ORIF), and Closed Reduction Internal Fixation (CRIF).

### Inclusion and Exclusion Criteria

Inclusion and exclusion criteria were determined before conducting a literature search. Studies that meet the inclusion criteria are as follows: (1). patients with a diagnosis of fracture of the neck of the femur, (2). compare ORIF with CRIF, (3). reported the results of one of the outcomes in the form of avascular necrosis (AVN), non-union, and malunion (coxa-vara), (4). The study design was in the form of a Randomized Controlled Trial (RCT) and observation (prospective or retrospective cohort), while the exclusion criteria were: (1) femur fractures other than the neck of the femur or multiple femur fractures, (2) articles that could not be obtained in full text. All authors carried out this review process.

### Data Extraction

Data extraction was carried out by including the first author's name and the article's year of publication used for identification purposes. The author extracts data independently and conducts discussions to determine existing problems.

### Output

There are three outcomes analyzed in this study, namely: (1) avascular necrosis (AVN), (2) non-union, and (3) malunion, in this case coxa-vara.

### Study Quality Assessment

All study designs were RCTs according to inclusion criteria, so The Cochrane Collaborations Tool for Assessing Risk of Bias was used with low risk, unclear risk, and high-risk scores. This tool is used to assess the

quality of the RCT methodology by assessing selection, performance, detection, attrition, reporting, and other biases.<sup>8</sup> As for observational studies, the New Castle Ottawa Scale was used to assess case-control or cohort studies (retrospective or prospective), with a score of 6-9: good quality, 3-5: medium quality, and 0-2: poor quality. The level of evidence (LE) was assessed for each included study according to the Oxford Center for Evidence-Based Medicine criteria. For each study, the more items meeting the requirements, the higher the quality considered. This procedure was carried out independently by all authors. Any disagreements are resolved by discussion.

### Statistic Analysis

Meta-analysis was performed using Software Review Manager (RevMan V.5.3, Cochrane Collaboration, Oxford, English). Odds Ratio (OR) and Risk Ratio (RR) combined summary statistics are calculated for dichotomous variables, including all outcomes in this case. OR and RR are reported with 95% Confidence Intervals (CI). The Cochrane Chi-Square test and inconsistency (I<sup>2</sup>) were used to assess study heterogeneity. The value of  $p < 0.05$  indicates a significant difference for each variable, while  $I^2 < 50\%$  indicates acceptable heterogeneity.

## Result

### Study

The stages of the article search results are shown in Figure 2, which produces 124 articles in the search results that have continuity or relevant study potential. After reviewing according to the PRISMA guidelines, seven pieces that met the requirements were found, of which a total of 203 ORIF cases and 396 CRIF cases were obtained. The case was then processed in a statistical meta-analysis based on predetermined selection criteria.

### Characteristics and quality of studies

The characteristics of each study included in the inclusion criteria are shown in Table 1. Determination of the Level of Evidence in seven studies, in which there were six retrospective cohorts (LE; 3b) and one prospective cohort (LE; 2b), and the quality of the methodological assessment is presented in Figure 1.

### Meta-analysis result

#### Avascular Necrosis (AVN)

In the AVN outcome, there was no significant difference between ORIF and CRIF (OR 1.06, 95% CI 0.49 to 2.29,  $p = 0.08$ , figure 3) with heterogeneity ( $I^2 = 44\%$ ). This shows that the chance of AVN from the two procedures is the same.

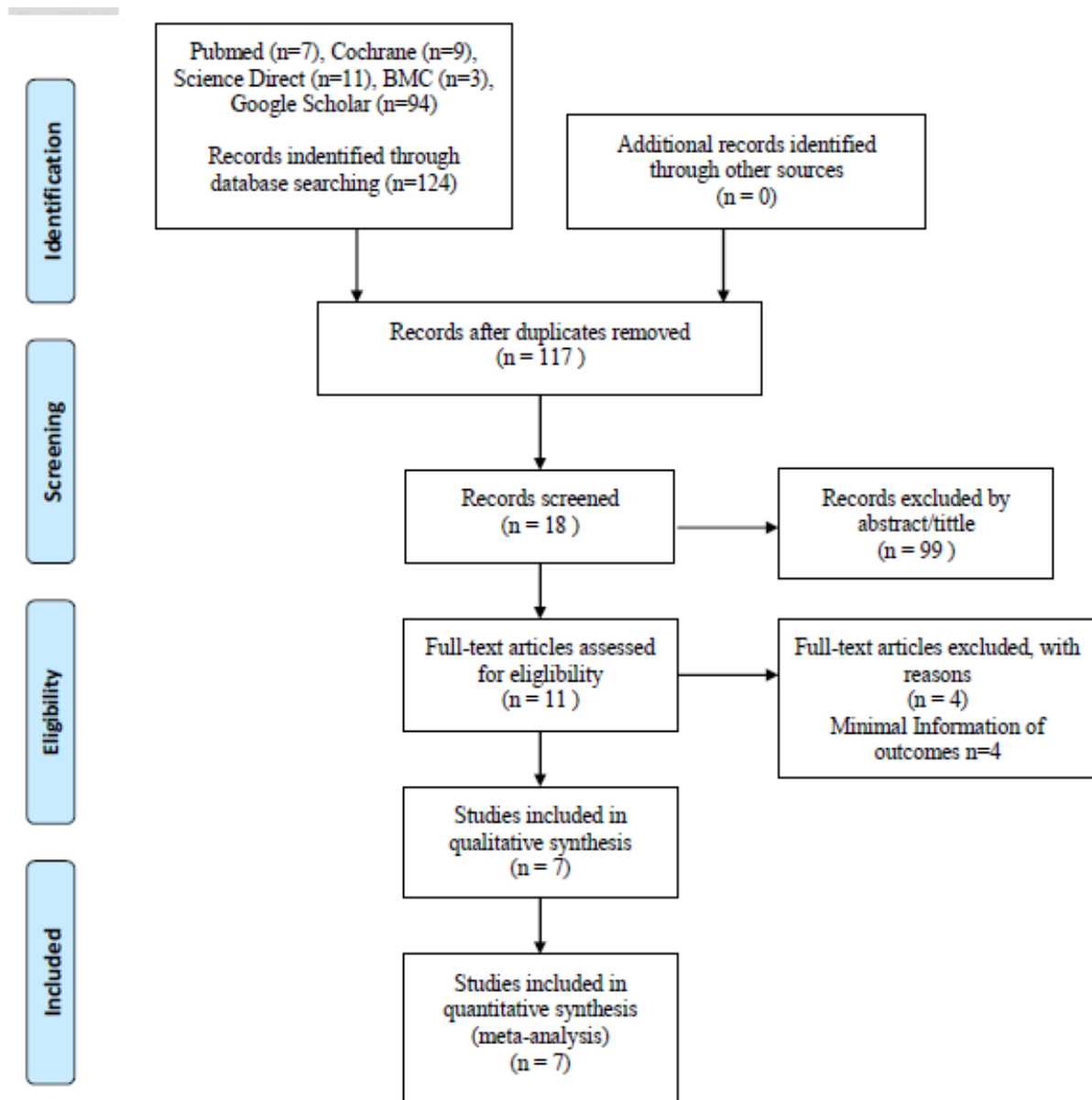


Figure 1. PRISMA Flow for article search

| <b>Table 1. ORIF vs CRIF: Summary of comparative studies</b> |               |      |                                |   |  |                                     |                      |    |                                   |
|--|---------------|------|--------------------------------|---|--|-------------------------------------|----------------------|----|-----------------------------------|
| Reference  | Country       | Year | Number of Patients (ORIF/CRIF) | ORIF Technique  | CRIF Technique   | Inclusion Criteria                  | Study Design         | LE | Quality Study (Newcastle Outcome) |
| Bali   | India         | 2011 | 29 (18/11)                     | Screw, <i>Partially Threaded Cancellous Screws, dynamic hip screw</i>                           | Using Spica  | Femoral Neck Fracture (Delbet type) | Retrospective Cohort | 3b | 8                                 |
| Ju   | China         | 2016 | 58 (37/21)                     | Use of Kirschner wire, and Screw Fixing   | The use of plates on the hip, wire, and screw fixation installation  | Femoral Neck Fracture (Delbet type) | Retrospective Cohort | 3b | 7                                 |
| Song   | Korea Selatan | 2010 | 27 (15/12)                     | Watson-Jones approach, longitudinal incision with screw fixation, K-wire, Use of screw + K-wire | screw fixation, K-wire, Use of screw + K-wire, hip spica   | Femoral Neck Fracture (Delbet type) | Retrospective Cohort | 3b | 7                                 |
| Upadhyay   | India         | 2004 | 92 (44/48)                     | Watson-Jones approach, reverse T-shaped incision, and use of Kirschner wires                    | Use of Steinmann pins, extension traction, and internal rotation, and fixation with 3 cannulated cancellous screws | Femoral Neck Fracture               | Retrospective Cohort | 2b | 7                                 |
| Wang   | China         | 2014 | 146 (28/118)                   | Install 2-3 cannulated cancellous screws.   | Install 2-3 cannulated cancellous screws   | Femoral Neck Fracture               | Retrospective Cohort | 3b | 7                                 |
| Wongwai  | Thailand      | 2012 | 26 (8/18)                      | Anterior arthrotomy, reverse T-shaped incision, and fixation with multiple screws               | Extension traction on the fracture table and fixation with multiple screws   | Femoral Neck Fracture               | Retrospective Cohort | 3b | 5                                 |
| Xie  | China         | 2012 | 221 (53/168)                   | Insertion of cancellous screws percutaneously   | Insertion of cancellous screws percutaneously  | Femoral Neck Fracture               | Retrospective Cohort | 3b | 7                                 |

LE (level of evidence), ORIF (Open Reduction Internal Fixation), CRIF (Closed Reduction Internal Fixation)

Table 1. ORIF vs CRIF: Summary of comparative studies

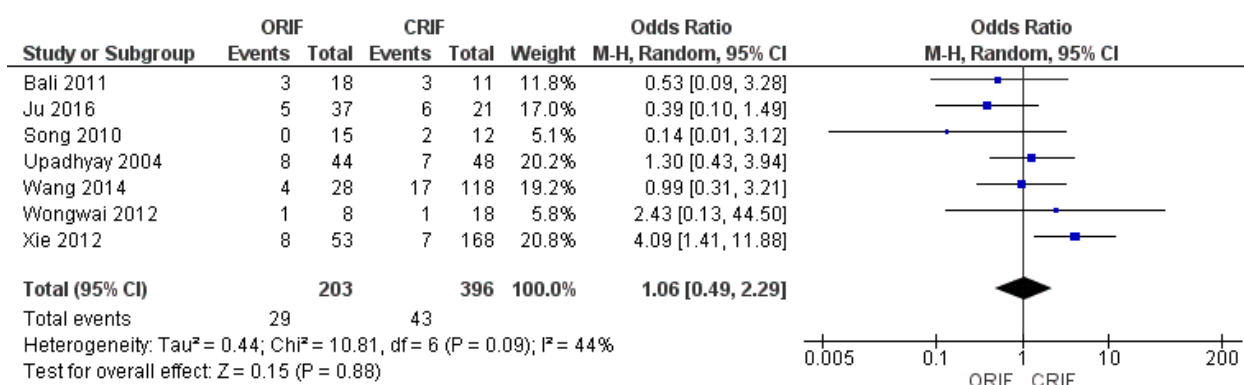


Figure 2. AVN Meta-analysis

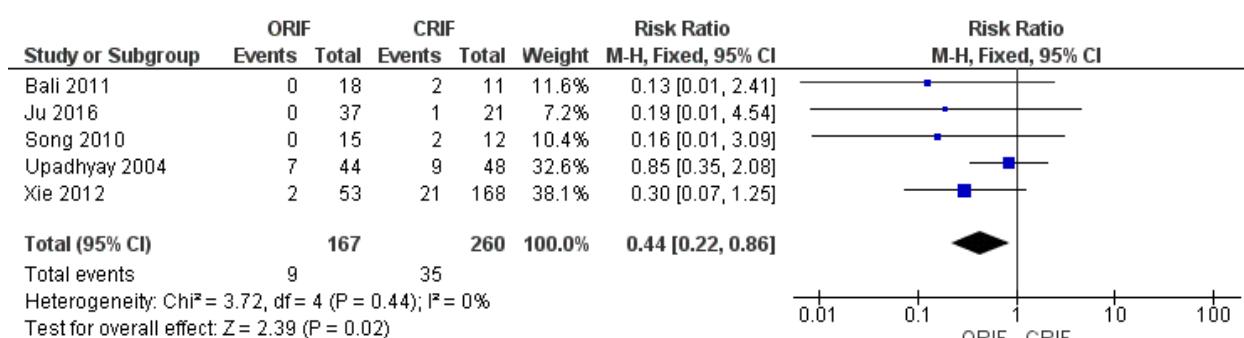


Figure 3. Non-union Meta-analysis

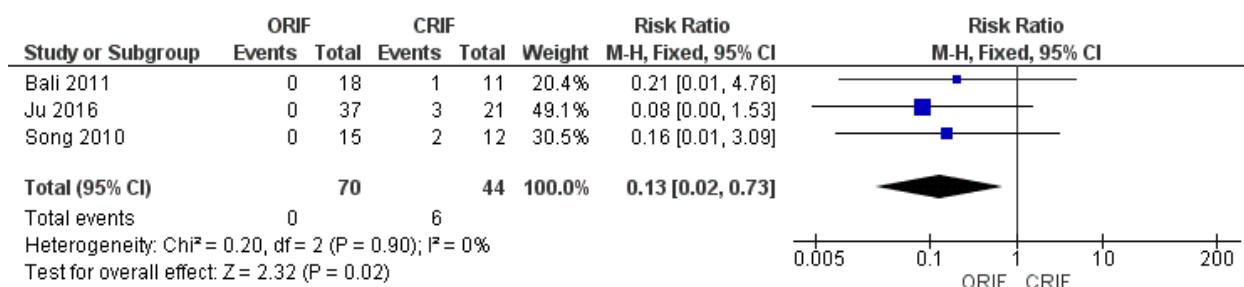


Figure 3. Malunion Meta-analysis (Coxa-vara)

### Non-Union

A comparison of non-union between the two procedures yielded results (RR 0.44, 95% CI 0.22 to 0.86,  $p = 0.02$ , Figure 4) with heterogeneity ( $I^2 = 0\%$ ) which means that the potential for non-union for the CRIF procedure is more significant than ORIF.

### Malunion (Coxa-vara)

From the two procedures, the results of a comparison of coxa-vara (RR 0.13, 95% CI 0.02 to 0.73,  $p = 0.02$ , figure 5) with heterogeneity ( $I^2 = 0\%$ ) stated that the chance of coxa-vara was more significant in the CRIF procedure compared to ORIF.

## Discussion

The surgical method of femoral neck fracture treatment is internal fixation. Internal fixation is one of the leading options in managing femoral neck fractures. Open Reduction Internal Fixation (ORIF) and Closed Reduction Internal Fixation (CRIF) are among them. Some complications arise after the procedure: avascular necrosis (AVN), non-union, and mal-union (coxa-vara).<sup>6,11,12</sup>

Many complications occur in femoral neck fractures, and AVN is one of the most serious. In addition to femoral neck fractures, which can cause

AVN, there is impaired blood flow to the head of the femur. Several factors influence the occurrence of AVN, the patient's age, fracture classification, method of operation, displacement and fixation, and the time of the process.<sup>13,14,18</sup> In this study, there was no significant difference in the occurrence of AVN using either the ORIF or CRIF methods; this is similar to previous research, which stated that there was no difference between the two.<sup>15</sup> In another study, it was also noted that the implementation of the ORIF method gave high complications for AVN. In contrast, Wang stated that the CRIF method also provided high complications for AVN. So there is no significant difference between the ORIF and CRIF methods.

In this study, there was a significant difference in the incidence of non-union and coxa-vara between the two groups. In the ORIF group, the occurrence of postoperative non-union was less than in CRIF, as well as the incidence of coxa-vara. This is like previous studies that increased non-union incidence due to inadequate reduction and fracture displacement; it was reported in several cases with the CRIF method.<sup>11</sup> And the ORIF method also provides a fairly good reduction method so that it can also reduce the incidence of non-union and coxa-vara.<sup>16,17,19,20</sup>

Even in practice, the CRIF method is rarely used because it requires difficult decisions. A surgeon must think about how to reduce it, using what method, and must be manipulated several times. So it often causes non-union and coxa-vara.<sup>21,22,23</sup>

First, this study still has some shortcomings regarding the procedures used in carrying out the many ORIF and CRIF actions. This will affect the results of the study. Second, there are still very few observational studies that we get so the number of samples in this study is still small. However, the results of the studies we collected showed significant results in the incidence of nonunion and malunion (coxa-vara). Significant data results can affect the conclusions of this study.

## Conclusion

ORIF has better effectiveness and safety than CRIF regarding the total incidence of union and malunion (coxa-vara) after surgery. There is no significant difference between the two in the occurrence of avascular necrosis.

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