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Original article

Proximal femoral nails antirotation, Gamma nails, and dynamic hip screws for fixation of intertrochanteric fractures of femur: A meta-analysis

K.-L. Ma[a], X. Wang[b], F.-J. Luan[a], H.-T. Xu[a], Y. Fang[c,*], J. Min[a], H.-X. Luan[a], F. Yang[a], H. Zheng[a], S.-J. He[a]

[a] *Yongchuan Hospital, Chongqing Medical University, Hua Road, No. 439, Yongchuan, Chongqing 402160, China*
[b] *The Chinese Medicine Hospital of Suqian, Hengshan Road No. 1, Suqian 223800, China*
[c] *West China Hospital, Sichuan University, Lane Sinology No. 37, Chengdu 610041, China*

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ABSTRACT

Background: Which surgical strategy is the best one for intertrochanteric fractures remains a controversial issue. Dynamic hip screw (DHS) and Gamma nail were commonly used but often associated with some complications, such as fixation failure and implant-related fractures. Meanwhile, proximal femoral nail anti-rotation (PFNA) fixation has recently been developed for minimally invasive surgery to reduce the complications rate. To facilitate the clinical decision-making, we conducted an updated meta-analysis to discuss the optimal treatment of intertrochanteric fractures aiming to determine which implant gives the lower rates of blood loss, complications (peri-implant fracture, fixation failure, infection, thromboembolic), reoperation, and mortality, as well as the minimal duration related to surgery (fluoroscopic exposure, surgery and hospital stay).

Patients and methods: Seven electronic databases were searched for randomized controlled trials (including OVID, Springer, Google Scholar, PubMed, Cochrane library, Embase, and Web of Science). Fourteen studies with 1983 patients were included. The modified Jadad Scale was used to assess the methodological quality of these studies. Risk of bias in the included studies was assessed using the Cochrane Risk of Bias tool. Comparison among the three groups was based on twelve indicators, including operative time, fluoroscopy time, operative blood loss, length of hospital stays, wound infection or hematoma, pneumonia, thromboembolic complications, fixation failure, operative fracture of femur, later fracture of femur, reoperation, and mortality.

Results: (1) PFNA group versus DHS group: PFNA was associated with less blood loss (mean difference (MD) −253.86, 95% CI −270.25 to 237.47; $P < 0.00001$) and lower rate of fixation failure (MD 0.20, 95% CI 0.07 to 0.59; $P = 0.004$), but led to more fluoroscopy time (MD 2.11, 95% CI 1.78 to 2.43; $P < 0.00001$). (2) PFNA group versus Gamma nail group: PFNA led to less blood loss (MD −55.30, 95% CI −60.07 to −50.53; $P < 0.00001$), shorter fluoroscopy time (MD −0.50, 95% CI −0.55 to −0.45; $P < 0.00001$) and length of hospital stay (MD −0.20, 95% CI −0.27 to −0.13; $P < 0.00001$). (3) DHS group versus Gamma nail group: DHS was associated with lower rate of operative fracture of femur (MD 0.31, 95% CI 0.11 to 0.89; $P = 0.03$), later fracture of femur (MD 0.16, 95% CI 0.06 to 0.43; $P = 0.0004$), and reoperation (MD 0.49, 95% CI 0.27 to 0.88; $P = 0.02$), but caused more blood loss (MD 29.49, 95% CI 8.27 to 50.70; $P = 0.006$). In contrast, there was no difference regarding operative time, infection hematoma, pneumonia, thromboembolic events, and mortality.

Discussion: PFNA should be a priority choice for treatment of intertrochanteric fractures with minimal rate of fixation failure, less blood loss and shorter length of hospital stay. DHS has distinct advantages over Gamma nail with lower rate of plant-related complications and should be preferred device for intertrochanteric fractures. However, owing to the low quality evidence currently available, more high-quality RCTs are needed to confirm these findings.

Level of evidence: Level II.

* Corresponding author. Department of Orthopaedics, West China Hospital of Sichuan University, Lane Sinology No. 37, Wuhou District, Chengdu 610041, China.
E-mail address: fangyue1968gk@163.com (Y. Fang).

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1. Introduction

With a growing aging population, the incidence of intertrochanteric fractures is rising [1]. It has been estimated that intertrochanteric fractures occur in more than 200,000 people each year in the United States, with reported mortality rates ranging from 15% to 30% [2].

There is a considerable debate regarding which is the optimal implant for fixing intertrochanteric fractures. Options for treating intertrochanteric fractures include extramedullary fixation and intramedullary fixation. Dynamic hip screw (DHS), the most representative implant of extramedullary fixation, has been considered the gold standard for treatment of intertrochanteric fractures. However, DHS often fails to give good results in the unstable and reverse oblique fracture, which limits its clinical use [3,4]. Gamma nail has been widely used for many years because of its inspiring clinical results [5,6]. Long-term studies, however, revealed that Gamma nail might cause higher intra-operative and late complications that often require revision surgery [7,8]. PFNA was designed to minimize the risk of these implant-related complications, and preliminary results suggested that this goal might have been achieved [9,10]. PENA provides angular and rotational stability, which is especially important in osteoporotic bone, and allows early mobilization and weight bearing on the affected limb [11,12]. Biomechanical tests have shown its biomechanical superiority to sliding hip screw or Gamma nail [13].

Recently, a number of prospective randomized trials have been performed to compare the management of intertrochanteric fractures using these three fixation methods. However, these studies were limited in sample size and quality of methodology, and failed to draw a definitive conclusion on which fixation method is optimal for intertrochanteric fractures in reducing complications and improving prognosis. Thus, to provide a strong support for clinical decision, we conducted an updated meta-analysis to evaluate the efficacy of three interventions in treatment of intertrochanteric fractures through twelve evaluation criteria. The questions that drive the current study were the following: which implant gives the lower rates of blood loss, complications (peri-implant fracture, fixation failure, infection, thromboembolic), reoperation, and mortality, as well as the minimal duration related to surgery (fluoroscopic exposure, surgery and hospital stay).

2. Methods

2.1. Inclusion criteria

2.1.1. Search strategy

The electronic databases of PubMed (1974–9/2013), Embase (1974–9/2013), and Web of Science (1966–9/2013), Cochrane Library (Issue 6, 2013), Embase (1974–9/2013), Google Scholar (1974–9/2013), Springer (1989–9/2013), and OVID (1992–9/2013) were searched using a sensitive methodological filter for etiology studies. The key words including "intertrochanteric fractures", "proximal femoral nail antirotation", "dynamic hip screw", and "Gamma nail" were used. Google Scholar and Medical matrix were also searched to investigate potentially relevant literature. In addition, the reference lists of included studies and all related review articles were checked for further trials, published or unpublished. Language and publication status date were not restricted, and gray literatures were also investigated, as well as ongoing trials.

2.2. Data collection and analysis

2.2.1. Selection of studies

The inclusion criteria are as follows:

- patients over 60 years old with stable or unstable peritrochanteric fractures (peritrochanteric or intertrochanteric), excluding the pathological fractures;
- interventions including, DHS Gamma nail, or PFNA fixation;
- prospective, randomized controlled trials.

Duplicates or multiple publications of the same study, case reports, and animal studies were excluded from this review.

Twelve indicators assessed the outcomes:

- operative time;
- fluoroscopy time;
- operative blood loss;
- length of hospital stays (days);
- wound infection or hematoma;
- pneumonia;
- thromboembolic complications;
- fixation failure;
- operative fracture of femur;
- later fracture of femur;
- re-operation;
- mortality.

Two authors independently undertook the screening of studies. An initial screening of titles and abstracts was performed to remove those that were obviously outside the scope of the review. When the title or abstract could not be rejected with certainty, the full text article was obtained for further evaluation.

2.2.2. Data extraction and management

Data were extracted for all studies that met the inclusion criteria. For each study, two review authors independently completed data extraction forms that were tailored to the requirements of this review. All disagreements were resolved by discussion between the two review authors. If consensus could not be made, a third review author would be asked to complete the data extraction form and discuss the paper with the other two authors until the consensus was reached. If any data were missing from the trial reports, the review authors would attempt to obtain the data by contacting the authors. Any disagreement was resolved by discussion.

2.2.3. Assessment of risk of bias in included studies

Two reviewers assessed each study according to the modified Jadad Scale independently [14]. In this scale, the maximum quality score is seven points. The points are given according to the following rules: two points for appropriate methods of randomization, two for appropriate methods of blinding, two for appropriate methods of allocation concealment, and one for all enrolled patients participate in the study except for those who quit with reason. Low quality studies were rated score zero to three points and high quality four to seven points.

2.2.4. Data synthesis

This study used the Review Manager 5.1 software for meta-analysis (Copenhagen: The Nordic Cochrane Centre, the Cochrane Collaboration). When there were dichotomous variables, risk ratios (RR) were calculated for each study. When the data were continuous and the standardized mean difference (SMD) or the mean difference (MD) was used, 95% confidence intervals were determined for all effect sizes. Heterogeneity was analyzed using Chi^2 tests before meta-analysis ($P = 0.05$). If there was no heterogeneity ($P \geq 0.05$, $I^2 < 50\%$), a fixed effect model was used, otherwise ($P < 0.05$) a random effect model was used. Sensitivity analysis was carried out by removing relevant research to observe whether the homogeneity and the results changed significantly. If it did, this was used to find the reason of heterogeneity for further analysis.