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Early Rehabilitation in Elderly after Arthroplasty versus Internal Fixation for Unstable Intertrochanteric Fractures of Femur: a Systematic Review and Meta-Analysis

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The purpose of this study was to compare the outcomes focusing on the functional outcome and clinical results of replacement arthroplasty (AP) vs. internal fixation (IF) for the treatment of unstable intertrochanteric femoral fracture in elderly. Systematic review and meta-analysis were performed on 10 available clinical studies (2 randomized controlled trials and 8 comparative studies). Subgroup analysis was performed by type of methodological quality. Partial weight bearing time in AP group was earlier than that in IF group (SMD = –0.86; 95% CI = –0.42, 1.29; P = 0.050). The overall outcomes such as mortality, reoperation rate, and complication showed no significant diffrence between the 2 groups (AP vs. IF). Therefore, this systematic review demonstrates that AP provides superior functional outcomes especially earlier mobilization, as compared to IF in elderly patients with an unstable intertrochanteric femoral fracture.

Keywords: Arthroplasty; Fracture Fixation; Meta-analysis; Hip Fractures

INTRODUCTION

Hip fractures are considered an important health problem in elderly populations, with considerable socioeconomic burden due to longer hospitalization, loss of independence, and increased mortality. Recent epidemiologic study on hip fracture indicate that the absolute number of hip fractures is expected to increase in the following decades (1).

Patients with hip fracture mostly require hospitalization and surgical intervention to minimize morbidity and mortality (2-5). Although surgical options for hip fractures are various, the main goals are early rehabilitation and return to previous social activities. Early stable fixation of hip fracture enables early rehabilitation. It leads to improvement of the short-term clinical outcome including ability to return to independent living, shortened length of stay and reduced risk for development of pressure ulcers, and possibly minimizes overall mortality rates and postoperative complications (6).

Currently, replacement arthroplasty (AP) or internal fixation (IF) are considered the 2 surgical options for stable fixation after hip fracture. Several meta-analysis studies report that replacement AP is a more suitable surgical option in patients with femur neck fracture (7-9). Although few studies report the more suitable option for early rehabilitation in patients with unstable intertrochanteric fracture, replacement AP vs. IF remains controversial (10).

The purpose of this meta-analysis study was to compare the functional outcome and clinical results of replacement AP vs. IF for the treatment of unstable intertrochanteric femoral fracture in elderly patients.

MATERIALS AND METHODS

Our current review and meta-analysis was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline (11).

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Study eligibility criteria

Studies were selected on the basis of the following criteria: 1) study design: randomized controlled trials (RCTs) or non-randomized comparative studies; 2) study population: patients with unstable intertrochanter fracture of the femur (Arbeitsgemeinschaft fur Osteosynthesefragen/Orthopaedic Trauma Association [AO/OTA] classification: 2 and 3 or Evans classification: unstable); 3) intervention: including AP (total hip arthroplasty (THA) or hemiarthroplasty) and IF such as an intramedullary nail or the sliding hip screw (control group); 4) follow-up time: 1 years at least; and 5) reporting at least 1 of the following main clinical outcomes: mortality, reoperations for any cause, complication-related medical condition or operation, functional outcome and mobilization time. Studies were excluded if they failed to meet the above criteria.

Search methods for identification of studies

A comprehensive search of all relevant RCTs and comparative studies was conducted through PubMed central, OVID Medline, Cochrane Collaboration Library, Web of Science, EMBASE, KoreaMed, and AHRQ, up to January 2016, with English and Korean language restriction. We used the following search terms: "arthroplasty," "prosthetic replacement," "internal fixation," "femoral intertrochanteric fractures," "unstable intertrochanteric fracture" and "randomized controlled study," "comparative study." These keywords were used as MeSH headings and free text words, respectively (Appendix 1). Manual search of possibly related references was also conducted. Two investigators independently reviewed the titles, abstracts, and full texts of all potentially relevant studies, as recommended by the Cochrane Collaboration (12).

Data extraction

The following data were extracted from the included articles: authors, publication date, study design, participant characteristics, follow-up period, specific interventions, and outcome measurements. The outcomes pooled in this analysis included mortality, reoperation, complications-related general condition or operation, functional outcome and mobilization time (weight bearing or starting day of rehabilitation). For the data published as median, range and the size of the trial, mean difference (MD) and standard deviation (SD) were calculated by the method of Hozo (13).

Methodological quality assessment

Two authors independently assessed methodological quality of included studies using the same criteria for RCTs and as described in the Cochrane Handbook for Systematic Reviews of Interventions 5.2. The criteria included 10 items as follows: 1) Allocation concealment; 2) Were inclusion and exclusion criteria clearly defined?; 3) Were the outcomes of patients who withdrew or were excluded after allocation described and included in an intention-to-treat analysis?; 4) Were the groups well matched, or appropriate covariate adjustment made?; 5) Did the surgeons have experience of the operations performed in the trial, prior to its commencement?; 6) Were the care programs other than the trial options identical?; 7) Were all the outcome measures clearly defined in the text with a definition of any ambiguous terms encountered?; 8) Were the outcome assessors blind to assignment status?; 9) Was the timing of outcome measures appropriate?; and 10) Was loss to follow-up reported and if so, was less than 5 percent of participants lost to follow-up?

The Newcastle-Ottawa scale was used to assess methodological quality of non-randomized studies. It contains 8 items, which are categorized into 3 dimensions: the selection of the study population, the comparability of the groups, and the ascertainment of the exposure (case-control study) or outcome (cohort study). Each dimension consists of subcategorized questions: selection (a maximum of 4 stars), comparability (a maximum of 2 stars), and exposure or outcome (a maximum of 3 stars) (14,15) Thus, a study can be awarded a maximum of 9 stars, indicating the highest quality.

Two of the authors independently evaluated the quality of all the studies.

Data analysis

This meta-analysis was performed with Review Manager software (Rev Man 5.3; the Nordic Cochrane Centre, Copenhagen, Denmark) and the level of significance was set at $P < 0.05$. For dichotomous outcomes, odds ratio (OR) and 95% confidence interval (CI) were calculated. For continuous outcomes, standardized mean difference (SMD) and 95% CI were calculated. The size of heterogeneity across studies was estimated with I^2 statistic and the χ^2 test. A P value of > 0.10 and an $I^2 \leq 50\%$ were considered of no statistical heterogeneity (15). For the test of heterogeneity, we used Higgins I^2 statistics. Significant heterogeneity was observed in these studies, therefore, we reported the data from a random-effects. Random effect model or fixed effect model were adopted depending on the heterogeneity of the included studies. Subgroup analysis was performed by type of methodological quality (RCT vs. non-RCT). Sensitivity analysis was conducted by omitting one study in each turn and pooling the data of the remaining studies to explore the possible explanations for high heterogeneity and determine the stability of the outcomes.

RESULTS

Search results

The initial search identified 301 references from the selected databases. Two hundred and seventy references were excluded by screening the abstracts and titles for duplicates, unrelated

articles, case reports, systematic reviews, and non-comparative studies. The remaining 31 studies underwent full text review. A further 21 studies were excluded. The details of identifying relevant studies were shown in the flow chart of study selection process (Fig. 1). Two randomized controlled studies and 8 comparative retrospective studies, 7 English articles (16-22) and 3 Korean article (23-25) including 1,214 patients (614 from AP group, 610 from IF group), were finally selected for this meta-analysis. The main characteristics and outcomes of the studies included in the meta-analysis were presented in Table 1.

Meta-analysis results

Mortality

Mortality rate (Fig. 2A): 6 studies (16-18,20,22,24) reported the mortality rate, a total of 914 participants with 462 patients assigned to the AP group and 452 patients assigned to the IF group. There was low evidence of heterogeneity across the studies (I^2 = 0%; P = 0.480) and the fixed model was performed. There was no statistically difference between AP group and IF group (OR = 1.20; 95% CI = 0.83, 1.73; P = 0.330; number needed to treat [NNT] = −48).

Reoperations

Reoperation Rate (Fig. 2B): 4 studies (16,18,22,24) reported the reoperation, a total of 711 participants with 365 patients assigned to the AP group and 346 patients assigned to the IF group. There was low evidence of heterogeneity across the studies (I^2 = 52%; P = 0.100) and the random model was performed. No statistical difference was observed between AP group and IF group (OR = 0.43; 95% CI = 0.12, 1.62; P = 0.210; NNT = 39).

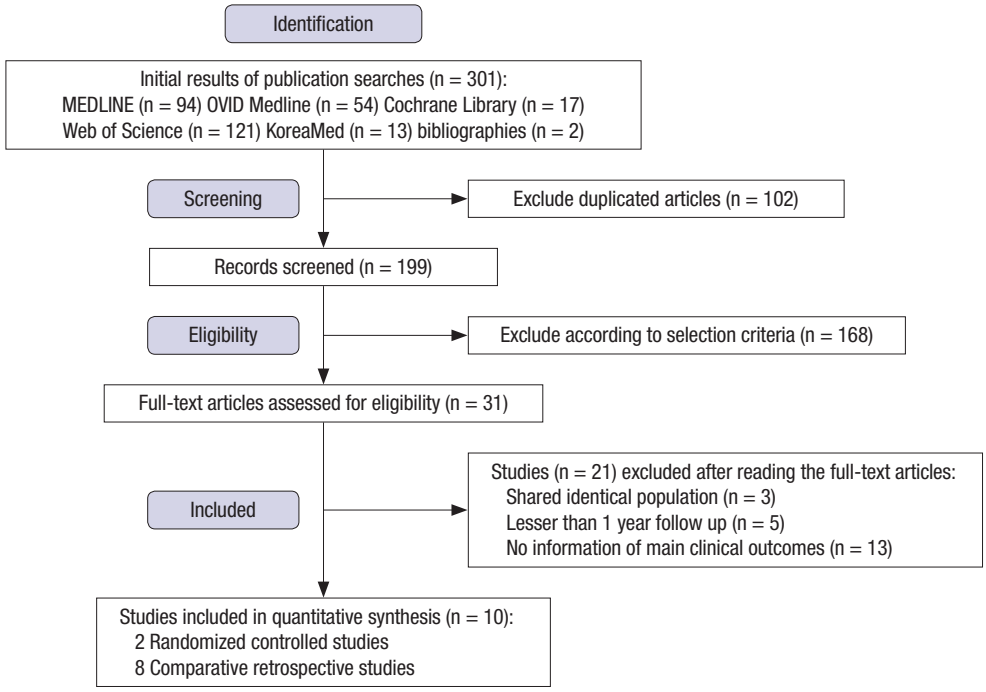

Fig. 1. PRISMA flow diagram details the process of relevant clinical study selection.
PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

Table 1. Characteristics of included studies and patients

Authors	Country	Year	Study design	Mean age (AP/IF)	Patient No. (AP/IF)	Follow-up (range or SD)
Kim et al. (19)	Korea	2005	RCT	82 ± 3.4/81.0 ± 3.2	29/29	35 m (24–58)/34 m (24–57)
Stappaerts et al. (21)	Belgium	1995	RCT	82.0 ± 3.4/81.0 ± 3.2	43/47	ND
Haentjens et al. (17)	Belgium	1989	CCT	82.0 ± 2.5/81.0 ± 1.9	37/42	ND
Tang et al. (22)	China	2012	CCT	81.1 ± 5.8/80.6 ± 6.9	156/147	44.2 m (16.9)/35.9 m (8.6)
Bonnevialle et al. (16)	France	2011	CCT	85.9/85.5	134/113	ND
Shen et al. (20)	China	2012	CCT	78.2 (70– 101)/76.8 (70–98)	60/64	ND
Kayali et al. (18)	Turkey	2006	CCT	73 ± 9/75 ± 6	42/45	24 m (8.3)/29 m (10.7)
Kim et al. (24)	Korea	2012	CCT	76.3 (65–89)/74.6 (65–84)	33/41	16.5 m/17.6 m
Kim et al. (25)	Korea	2014	CCT	79.7 ± 6.5/75.6 ± 6.5	46/43	2.4 yr (1.6)/2.1 yr (1.5)
Park et al. (23)	Korea	2009	CCT	79.4/71.9	34/39	51.8 m/53.4 m

AP = arthroplasty, IF = internal fixation, SD = standard deviation, RCT = randomized controlled trial, CCT = retrospective comparative control trial, ND = not documented.

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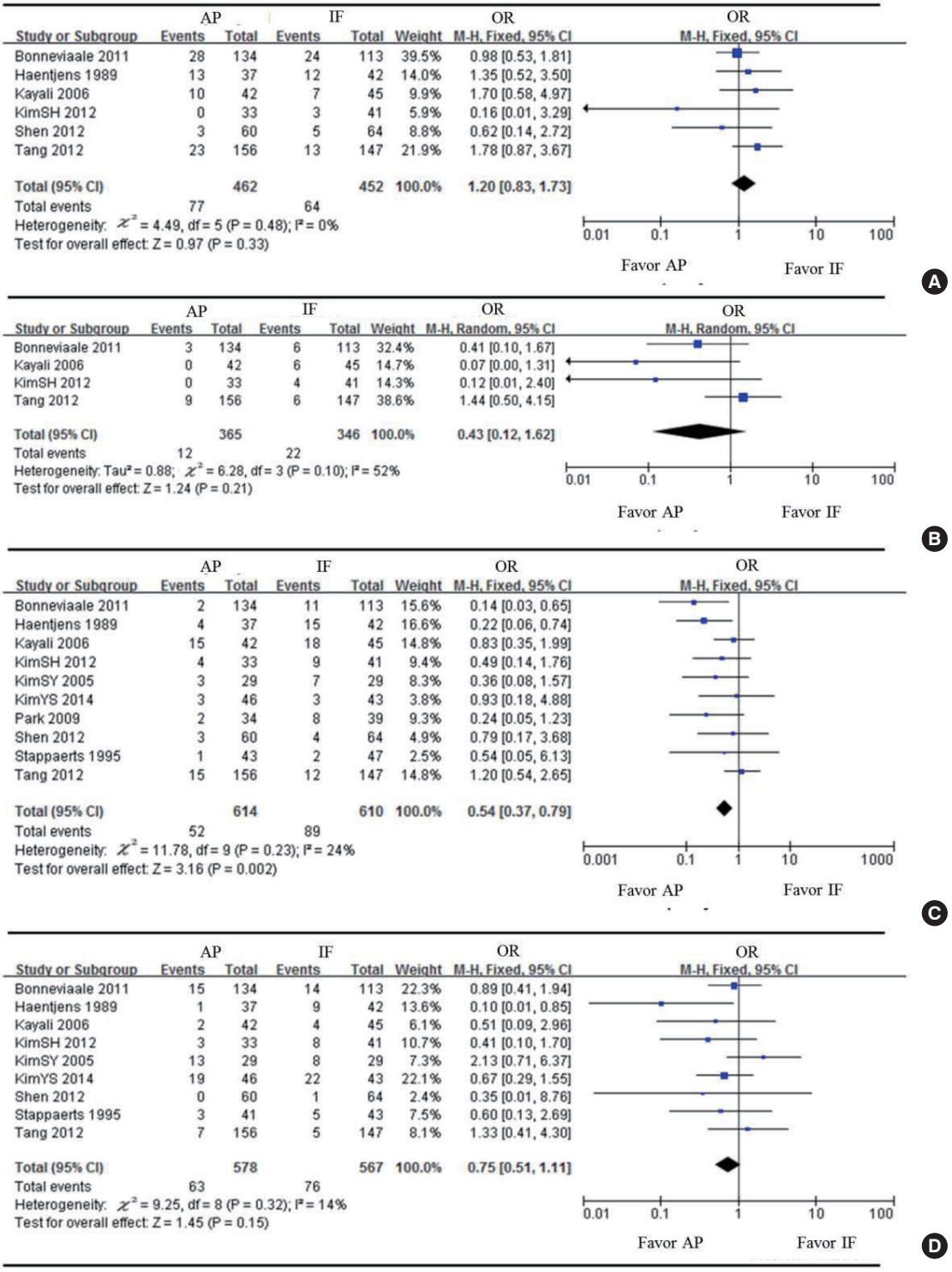

Fig. 2. The forest plot of the outcomes comparing AP with IF. (**A**) Mortality. (**B**) Reoperation. (**C**) Complication-related medical condition. (**D**) Complication-related operation.
AP = arthroplasty, IF = internal fixation, OR = odds ratio; CI = confidence interval, M-H = Mantal-Haenszel.

Complication related medical condition

Complication related medical conditions such as deep vein thrombosis, urinary tract infection respiratory, cardiovascular, and neurologic complication (Fig. 2C): 7 studies (16-18,20,22, 24,25) reported the overall complication in a total of 1,003 participants with 508 patients assigned to AP group and 495 patients assigned to the IF group. There was low evidence of heterogeneity across the studies (I^2 = 14%; P = 0.320) and the fixed

model was performed. There was no statistically difference between AP group and IF group (OR = 0.75; 95% CI = 0.51, 1.11; P = 0.150; NNT = 40).

Complication related operation

Complication related operation (Fig. 2D): 8 studies (16-24) reported the overall complication in a total of 1,076 participants with 542 patients assigned to AP group and 534 patients assigned to the IF group. No statistical difference was observed between AP group and IF group (OR = 0.54; 95% CI = 0.37, 0.79; P = 0.002; NNT = 16).

Funtional outcomes

Three studies (19,20,22), with a total of 477 patients provided mean Harris hip scores and SD postoperatively. There was low evidence of heterogeneity across the studies (I^2 = 0%; P = 0.830) and the fixed model was performed. Function was significant difference between 2 groups in the Harris hip scores at latest follow-up (SMD = –2.97; 95% CI = –5.09, 0.84; P = 0.006) (Fig. 3A).

Stappaerts et al. (21) described a simple and easy workable scale of independence to estimate the functional status. This scale was based on amulatory capacity and on the abilities of performing activities of daily living. To be considered as independent, the patient was required to meet at least the following criteria: ability to walk outdoors > 50 m without waking aids, except one cane or crutch, and ability to dress him- or herself and get up from an armchair without assistance. They reported that there was no significant difference between the 2 groups.

The Merle d'Aubigne score was used for functional outcome measurement in one study (17). They reported that rehalbiliatation was easier and faster in the AP group. The Parker score and Postel Merle d'Aubigne (PMA) score were used for functional outcome measurement in other study (16). AP group showed significantly better functional results after postoperative 6 months in terms of final Parker score, overall PMA score, and all 3 PMA items. Kayali et al. (18) evaluated functional outcome according to Merle d'Aubigne and Postel criteria at final follow-up. Patients with > 14 points were considered to have achieved a satisfactory operative result. In AP group, the outcome of 8 patients was deemed unsatisfactory (6 fair, 2 poor). In IF group, clinical results were deemed excellent in 11 patients and good in 15. The Merle d'Aubigne score was used for functional outcome measurement in another study (25). They reported that Merle d'Aubigne and Postel score was not significantly different between the 2 groups.

Kim et al. (24) measured functional outcome using Koval score and modified Harris hip score. In the MD of Koval score and Modified Harris hip score, IF group (1.4 and 1.3) showed significantly greater increase than that of AP group (1.9 and 6.0). However, limp and waking aids of modified Harris hip demonstrated that AP group (7.8 and 7.9) had significantly higher score than that of IF group (6.2 and 6.5).

Park et al. (23) evaluated functional outcome using the Johnson daily activity of life score. At the final follow-up, the Johnson daily activity of life score showed more excellent results in AP group (P = 0.010).

Mobilization time

Two studies (19,25), with a total of 147 patients provided mean time of partial weight bearing with walking aids and SD at postoperatively. There was low evidence of heterogeneity across the studies (I^2 = 83%; P = 0.010) and the random model was performed. Partial weight bearing time was significant different between the 2 groups (SMD = –0.86; 95% CI = –0.42, 1.29; P = 0.050) (Fig. 3B).

Kim et al. (19) reported that the patients in AP group were able to walk with a walker at a mean of 7.8 ± 1.6 days postoperative-

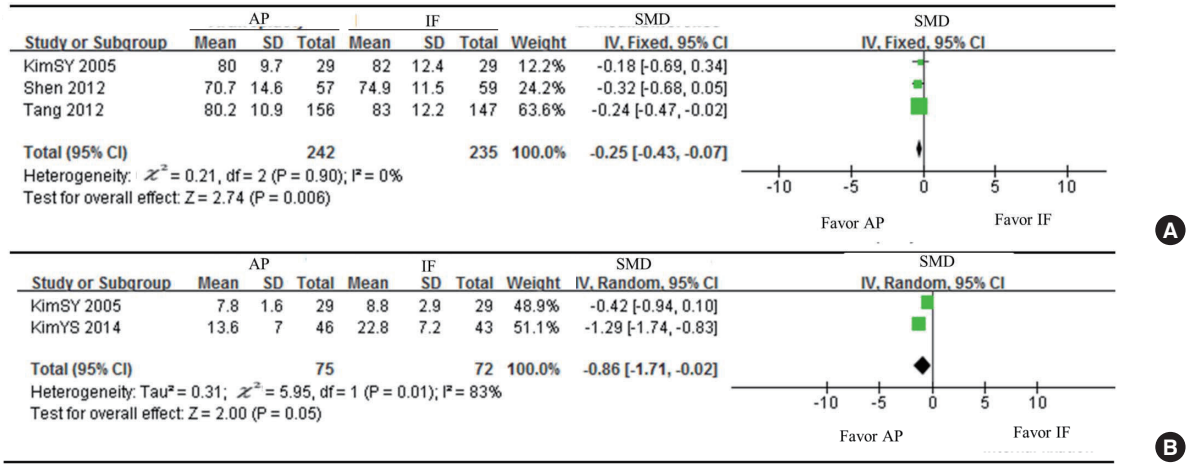

Fig. 3. The forest plot of the outcomes comparing AP with IF. (**A**) Functional outcome. (**B**) Mobilization time.
AP = arthroplasty, IF = internal fixation, SMD = standardized mean difference, SD = standard deviation, CI = confidence interval, MH = Mantal-Haenszel.

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ly, and those in IF group at a mean of 8.8 ± 2.9 days (P = 0.069). Kim et al. (25) reported that the AP group were able to begin partial weight-bearing earlier (13.6 ± 7.0 days in AP group vs. 22.8 ± 7.2 days in IF group, P < 0.001). Tang et al. (22) reported that the median time of starting partial weight-bearing using a walker was 10.0 days in IF group, and 4.0 days in AP group. Patients in AP group were able to begin partial weight-bearing earlier (P < 0.001).

Shen et al. (20) recorded postoperative mobility status using walking ability (grade 1: no aid was needed; grade 2: aid was need, but patient was independent; and grade 3: patient was in need of assistance). Comparing mobility at 6 and 24 months post-operation with the pre-fracture status, they found that the IF group that contained the highest proportion of patients who maintained their preoperative status was satisfactory, followed by the AP group, and the unsatisfactory IF patients.

Kayali et al. (18) reported that the time to full weight bearing was significantly earlier in patients who underwent hemiarthroplasty (4.0 ± 1.5 weeks in AP group vs. 10.0 ± 2.0 weeks in IF group, P < 0.001).

Kim et al. (24) reported that the time to free weight bearing without walking aids was significantly earlier in patients who underwent AP (AP: 15.3 days (range, 10–21) vs. IF: 19.1 days (range, 14–23), P < 0.050).

Subgroup and sensitivity analysis

Subgroup analysis according to type of methodological quality (RCT vs. non-RCT) showed similar results. However, functional outcome (Harris hip score, HHS) excepting results of non-RCTs was no significant differences between AP group and IF group (80.0 ± 9.7 vs. 82.0 ± 12.4, P = 0.282) Sensitivity analysis yielded similar results.

Risk bias

Only 2 RCTs were reported on this issue and the 8 included studies were comparative studies. The Cochrane Handbook for Systematic Reviews of Interventions was used to assess the quality of 2 RCTs. Scoring in 2 RCTs were 7 and 4, respectively (Appendix 2). The Newcastle-Ottawa scale was used to assess the quality of the selected studies. All included studies scored 5–8 points, indicating relatively high quality (Appendix 3). A funnel plot was not applied to assess publication bias due to small size (< 10) of RCTs included in this meta-analysis.

DISCUSSION

To achive early rehabilitation and improved short-term outcomes, this meta-nalysis study demonstrated more excellent funtional assessment in AP and significantly earlier partial weight bearing time in AP group than in IF group. Previously, only one meta-anlysis compared replacement AP with IF for the treatment of unstable intertrochanteric femoral fractures in elderly patients (10). They performed meta-analysis using 2 RCTs including a total of 148 patients aged 70 years or over with unstable intertrochanteric femoral fracture. They reported that there were no significant differences between the 2 interventions for mechanical complications, local wound complications, reoperation, general complications, mortality at 1 year or long-term function. However, the review of only 2 clinical trials is not adequate for a definite conclusion and they recommended that larger well-designed randomised trials comparing AP vs. IF for the treatment of unstable fractures are required.

In terms of functional recovery and starting time for rehabilition, 2 studies reported that partial weight bearing time in replacement AP groups was significantly better than IF groups (19,25). However, assessment tools of functional outcomes are not consistent. Merle d'Aubigne score was most frequently used functional score (15-17,24). Although meta-analysis could not be conducted as it did not provide both mean and SD, most studies reported that rehabilitation treatments could be mobilized more easily, conveniently and faster in AP group.

Regarding surgical-related complications such as reoperation and mortality in patients after treatment of unstable intertrochanteric fracture, this meta-anlysis indicated no statistical difference between AP and IF treatment for unstable intertrochanteric fracture in elderly patients. These findings are consistent with previous meta-analysis.

This meta-analysis has some limitations. First, only 2 RCTs were included. Second, follow-up periods were not long enough to confirm the results (none of the included studies had more than 5-year follow-up). Third, all retrieved documents were English or Korean, hence, there may be language bias. Well-reported, high-quality RCTs with long-term follow-up are needed to assess the safety and efficacy of AP compared to IF. Finally, we could not perform meta-analysis of the degradation between preoperative and postoperative functional outcomes. Difficulty of direct comparison of functional outcome is possibly due to deficiency of unified functional evaluation tools.

In conclusion, the present study suggests that AP provides superior functional outcomes especially earlier mobilization when compared with an IF in elderly patients with an unstable intertrochanteric femoral fracture.

DISCLOSURE

The authors have no potential conflicts of interest to disclose.

AUTHOR CONTRIBUTION

Conceptualization: Yoo JI, Ha YC, Lim JY. Data curation: Kang H, Yoon BH, Kim H. Investigation: Yoo JI, Ha YC. Writing - review & editing: Yoo JI, Ha YC.

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Appendix 1. Search Strategy for PubMed on October 15, 2016

No.	Keyword	Search category
1	Hip Fractures	MeSH
2	Fracture Fixation, Internal	MeSH
3	Fracture Fixation/*instrumentation	MeSH
4	Femoral Intertrochanteric Fracture*	All fields
5	Intertrochanteric Femur Fracture*	All fields
6	Unstable Femoral Intertrochanteric Fracture*	All fields
7	Unstable Intertrochanteric Femur Fracture*	All fields
8	Unstable Intertrochanteric Fracture* of Femur	All fields
9	Unstable Intertrochnanteric Fracture*	All fields
10	Unstable Intertrochanteric Femoral Fracture*	All fields
11	OR/1–10	
12	AP	MeSH
13	AP, Replacement, Hip	MeSH
14	Hemiarthroplasty	MeSH
15	Uniarthroplasty	All fields
16	OR/12–15	
17	IF	All fields
18	Internal Fixators	MeSH
19	OR/17–18	
20	16 AND 19	
22	Compression Hip Screw	All fields
23	Prosthetic Replacement	All fields
24	OR/20–22	
25	20 OR 24	
26	11 AND 25	

AP = arthroplasty, IF = internal fixation.

Appendix 2. Methodological quality assessment of RCT studies measured by Cochrane Handbook for Systematic Reviews of Interventions

References	1	2	3	4	5	6	7	8	9	10	Total study
Kim et al. (19)	1	1	1	1	0	0	1	0	1	1	7
Stappaerts et al. (21)	1	1	0	1	0	0	0	0	1	0	4

RCT = randomized controlled trial.

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Appendix 3. Methodological quality assessment of non-RCT studies measured by Newcastle-Ottawa scale

References	Selection	Comparability	Exposure	Total score
Haentjens et al. (17)	2	2	3	7
Tang et al. (22)	4	1	3	8
Bonnevialle et al. (16)	2	2	3	7
Shenet al. (20)	2	2	3	7
Kayali et al. (18)	1	2	2	5
Kim et al. (24)	2	2	1	5
Kim et al. (25)	3	2	1	6
Park et al. (23)	2	2	2	6

RCT = randomized controlled trial.