The purpose of this study was to compare minimally invasive and conventional dynamic hip screw techniques for the treatment of intertrochanteric fractures in older patients. Relevant randomized, controlled studies were included. The methodological quality was assessed, and data were extracted independently. Five studies (353 fractures) that compared minimally invasive and conventional dynamic hip screw techniques were included. The rates of serious postoperative complications, operative time (minutes), hemoglobin decrease (g/dL), postoperative Harris Hip Scores, and length of stay (days) were the outcomes of interest. A lower rate of serious postoperative complications was correlated with the minimally invasive dynamic hip screw group compared with the conventional dynamic hip screw group (relative risk, 0.35; 95% confidence interval [CI], 0.16, 0.78), average operative time (weighted mean difference, −16.32; 95% CI, −28.78 to −3.86), hemoglobin decrease (weighted mean difference, −1.44; 95% CI, −1.98 to −0.89), and length of stay (weighted mean difference, −3.72; 95% CI, −5.44 to −2.01) were lower in the minimally invasive dynamic hip screw group, and the postoperative Harris Hip Score (weighted mean difference, 1.42; 95% CI, 0.23 to 2.60) was higher in the minimally invasive dynamic hip screw group.
Intertrochanteric fractures are commonly observed in elderly patients and are a significant orthopedic burden. Closed methods of treating intertrochanteric fractures have been abandoned. Rigid fixation with early mobilization should be considered as the standard treatment. The dynamic hip screw has become the standard and is currently the most common implant used to fix intertrochanteric fractures. The potential disadvantages of the conventional dynamic hip screw are an at least 10-cm split of the vastus lateralis muscle and considerable soft tissue dissection, blood loss, and pain, which may negatively affect elderly patients with multiple comorbidities.

Use of the minimally invasive dynamic hip screw as a minimally invasive implant for intertrochanteric fracture fixation is gaining popularity in trauma surgery, with potential benefits including decreased bleeding and postoperative pain, a lower risk of serious postoperative complications, and earlier mobilization.

A few recent trials that had small sample sizes compared the management of intertrochanteric fractures using the conventional and the minimally invasive dynamic hip screw.

The purpose of this study was to answer the following questions:
1. Does the minimally invasive dynamic hip screw cause fewer serious postoperative complications than the conventional dynamic hip screw?
2. Does the minimally invasive dynamic hip screw reduce operative time compared with the conventional dynamic hip screw?
3. Does the minimally invasive dynamic hip screw reduce hemoglobin decrease compared with the conventional dynamic hip screw?
4. Is postoperative length of stay decreased in the minimally invasive dynamic hip screw group compared with the conventional dynamic hip screw group?
5. Does a difference exist in Harris Hip Scores postoperatively between the minimally invasive and conventional dynamic hip screw groups?

**Materials and Methods**

Meta-analysis is a data-pooling method that increases statistical power for defined end points and subgroups and systematically analyzes conflicting reports. Prior to starting the systematic search, the research question, inclusion and exclusion criteria, treatments of interest, and outcomes of interest were defined.

For inclusion of an article included (1) the studies compared the minimally invasive dynamic hip screw with the conventional dynamic hip screw; (2) when several articles reported the same patient material, the most recent article or the article with the greatest detail of information was selected; and (3) the literature was written in English.

Exclusion criteria included (1) studies in which the surgical technique (minimally invasive or conventional dynamic hip screw) could not be defined and (2) studies in which the outcome of the comparison of the techniques was not reported or able to be calculated from the published results.

**Treatments of Interest**

The minimally invasive and conventional dynamic hip screws were compared on the following factors: serious postoperative complications, operative time (minutes), hemoglobin decrease (g/dL), length of stay (days), and postoperative Harris Hip Score. Serious complications included but were not limited to death, wound infection, implant failure (lag screw cut out of the femoral head, bent or broken side plate, or loosened cortical screws), refracture, deep venous thrombosis (DVT), pulmonary embolism, and avascular necrosis of the femoral head.

**Search Technique and Data Extraction**

An Internet-based search on PubMed using the keywords dynamic hip screw and intertrochanteric fracture identified relevant studies published in English between 1966 and April 2011. Articles that had relevant titles were retrieved and assessed for inclusion. The quality of the nonrandomized studies was assessed using the Newcastle-Ottawa Scale, with some modifications to match the needs of this study. Five articles fulfilled the criteria and were selected.

Data were collected by 2 independent researchers (X.Z., Y.W.), who screened titles, abstracts, and keywords electronically and by hand; differences were resolved by discussion. The studies were assessed in terms of blinding, allocation concealment, follow-up coverage, and quality level (according to whether allocation concealment was adequate [A], unclear [B], inadequate [C], or not used to assess the study quality [D]).

**Statistical Analysis**

The relative risk was calculated in each study for dichotomous outcomes, and the weighted mean difference (WMD) was calculated for continuous outcomes using the Review Manager version 5.0 software (Cochrane, Oxford, United Kingdom). The relative risk and WMD adopted a 95% confidence interval (CI). Heterogeneity was tested using the chi-square test and the I-square test. A significance level of <.10 for the chi-square test was interpreted as evidence of heterogeneity. The I-square test was used to estimate the total variation among the studies. When no statistical evidence of heterogeneity existed, a fixed effects model was adopted. Otherwise, a random effects model was chosen. We did not include the possibility of publishing bias due to the small number of studies included.

**Results**

Using the criteria, 5 studies comparing the minimally invasive and the conventional dynamic hip screw were identified. The number of fractures in each study ranged from 48 to 102. A total of 401 fractures occurred; 189 fractures were managed with the minimally invasive dy-
dynamic hip screw, and 212 were managed with the conventional dynamic hip screw. Most research evaluated the serious complications, operative time, hemoglobin decrease, length of stay, and postoperative Harris Hip Score.

The quality of 4 studies2,5,7,8 was level B because the allocation concealment was unclear according to the evaluation criteria, and the other study6 was level A (Tables 1, 2).

Serious complications occurred in 7 of 189 fractures managed with the minimally invasive dynamic hip screw and 23 of 212 fractures managed with the conventional dynamic hip screw. Heterogeneity tests indicated no statistical evidence of heterogeneity ($\chi^2 = 2.48; P = .58, I^2 = 0\%$). Data that were pooled using a fixed-effects model indicated a lower rate of serious postoperative complications with the minimally invasive compared with the conventional dynamic hip screw (relative risk, 0.35; 95% CI, 0.16, 0.78, respectively) ($P = .01$) (Figure 1). Sensitivity analysis for serious postoperative complications did not identify significant differences in the relative risk of heterogeneity using random and fixed-effects models (Figure 2).

When compared with the conventional dynamic hip screw, the average operative time (WMD, $-16.32; 95\%$ CI, $-28.78, -3.86$, respectively), hemoglobin decrease (WMD, $-1.44; 95\%$ CI, $-1.98, -0.89$, respectively), and length of stay (WMD, $-3.72; 95\%$ CI, $-5.44, -2.01$, respectively) decreased with the minimally invasive dynamic hip screw. (Heterogeneity tests indicated statistical evidence of heterogeneity. Data were pooled using a...
random-effects model.) The postoperative Harris Hip Score (WMD, 1.42; 95% CI, 0.23, 2.60, respectively) was higher in the minimally invasive dynamic hip screw group (Figures 3-6). (Heterogeneity tests indicated no statistical evidence of heterogeneity \( \chi^2 = 1.05; P = .59; I^2 = 0\% \). Data were pooled using a fixed-effects model.)

**DISCUSSION**

 Although many internal fixation devices provide sufficient stabilization, the surgical treatment of intertrochanteric femoral fractures is still challenging.10 The dynamic hip screw, which provides rigid fixation and allows early mobilization because it enables optimal collapse and compression of the fracture site,7 is the most common extramedullary device used for intertrochanteric fractures and has reasonable results.11-13 In addition, when compared with sliding hip screws, no evidence exists of a reduced failure rate with intramedullary nails in unstable intertrochanteric fractures.14 Therefore, the routine use of intramedullary hip screws has not been recommended for the treatment of intertrochanteric fractures,15 and the dynamic hip screw is still the standard type of fixation for intertrochanteric fractures.11,16

However, insertion requires a 10-cm incision splitting the vastus lateralis, causing considerable bleeding and damage to the overlying soft tissues, and intertrochanteric fractures often occur in the elderly, who commonly have multiple comorbid conditions that may be worsened by the surgical trauma associated with a major operation.7 Therefore, the development of the minimally invasive dynamic hip screw, which causes less tissue damage and bleeding and shorter operative times and provides good fixation, may result in better outcomes, especially in elderly patients.

This meta-analysis indicates that the minimally invasive dynamic and conventional hip screws have statistical differences in operative time (WMD, 216.32; 95% CI, 228.78, 23.86, respectively), hemoglobin decrease (WMD, 21.94; 95% CI, 21.98, 20.89, respectively), and length of stay (WMD, −3.72; 95% CI, −5.44, −2.01, respectively). A reduced operative time, especially in elderly patients with comorbid conditions or poor cardiopulmonary reserve, is desirable because it reduces temporal exposure to the risks of general anesthetic. This, combined with reduced surgical trauma, may be significant in reducing postoperative morbidity and mortality in such patients. With regard to surgical blood loss, a previous angiographic study revealed that the average distance from the vastus lateralis ridge to the first significant branch was 9.3 cm.2 However, this area is a safe vascular zone.

In the minimally invasive dynamic hip screw technique, a 3-cm incision is made, and the incision point is approximately 4 cm below the vastus lateralis ridge. Therefore, blood loss decreases due to less soft tissue dissection, less fracture exposure, and because an incision is made in the safe vascular zone.7 Because decreased blood loss is thought to be an explanation of reduced cardiovascular complications, which decreases the need for blood transfusion, this may have great clinical significance.5,8 Early mobilization largely depends on the reduction of postoperative pain, and some studies show a trend toward lower pain scores in the minimally invasive dynamic hip screw group,2,6 which may encourage earlier ambulation and, theoretically, facilitate earlier discharge. The minimally invasive dynamic hip screw requires less operative time, reduces the amount of intraoperative blood loss, and allows patients to be discharged sooner, which may benefit patients’ recoveries and has significant financial implications for hospitals.
The rate of serious postoperative complications was 3.7% in the minimally invasive dynamic hip screw group and 10.8% in the conventional dynamic hip screw, with significant differences. In the conventional dynamic hip screw group, patients developed DVT (n=6), avascular necrosis of the femoral head (n=6), implant failure (n=6), surgical wound infections (n=4), atrial fibrillation (n=1), urinary tract infection (n=1), and pulmonary embolism (n=6), and 2 patients died. In the minimally invasive dynamic hip screw group, patients developed DVT (n=2), avascular necrosis of the femoral head (n=2), and implant failure (n=2), and 1 patient died. Postoperatively, elderly patients are at high risk of DVT, urinary tract infections, and pulmonary embolism if they fail to mobilize or ambulate early. Reduced operative time, less bleeding, and less postoperative pain may promote earlier ambulation in the minimally invasive dynamic hip screw group, which may contribute to a more favorable outcome in terms of serious postoperative complications. The implant failure rates were similar between the 2 groups, possibly because they were unstable fractures with loss of medial calcar continuity and with osteoporosis, and bone grafting was not achieved intraoperatively.7,8 The minimally invasive dynamic hip screw is safer and more dependable than the conventional dynamic hip screw because of the serious postoperative complications and should be the first option for older patients.

The Harris Hip Score is a multidimensional observational assessment that contains 8 items representing pain, walking function, activities of daily living, and hip joint range of motion.17 The score is reported as excellent (90-100), good (80-89), fair (70-79), poor (60-69), and failed (<60). Because of early mobilization and functional exercise, the postoperative Harris Hip Score (WMD, 1.42; 95% CI 0.23, 2.60, respectively) was higher in the minimally invasive dynamic hip screw group, which demonstrates that both methods are useful in the treatment of intertrochanteric fractures.

Because intertrochanteric fractures usually occur in elderly patients who may have cognitive deficits from age or have medical diseases, it is important for patients to return to preinjury activity levels as soon as possible to avoid complications. These advantages make the minimally invasive dynamic hip screw beneficial for older patients.

This study has limitations. Although every effort was made to ensure our results were accurate, not all related randomized trials were included because of publication bias, which may have excluded obvious outcome differences of the 2 treatment methods,18 and selection bias, which may have excluded selective studies that preferred some kind of treatment.19 Strict searches in the library and included bibliographies were conducted to reduce bias.

The purpose of this study was not to test different modifications of the minimally invasive dynamic hip screw or the seniority of the surgeons. Despite our efforts at standardization, our outcome measures were less well defined and, therefore, less absolute than would have been ideal. In addition, the included trials had a relatively low number of patients.

CONCLUSION

The minimally invasive dynamic hip screw and the conventional dynamic hip screw are effective, simple, and safe for the treatment of intertrochanteric fractures. Compared with the conventional dynamic hip screw, the minimally invasive dynamic hip screw has a shorter operative time, less hemoglobin decrease, a lower rate of serious postoperative complications, better functional results, and a shorter length of stay, which benefit patients and reduce hospital costs.

REFERENCES