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Review

Sliding hip screw versus cannulated cancellous screws for fixation of femoral neck fracture in adults: A systematic review

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ABSTRACT

Objective: Femoral neck fracture is considered a difficult fracture to treat and often gives rise to unsatisfactory treatment results. Cannulated cancellous screws (CCS) or a sliding hip screw (SHS) are the mainstream internal fixations used for osteosynthesis of femoral neck fractures. There is a need to integrate existing data through a meta-analysis to investigate the safety and effectiveness of CCS and SHS in the treatment of femoral neck fractures.

Method: According to the Cochrane Handbook for Systematic Reviews of Interventions, we screened for the relevant studies by searching Google Scholar, the Cochrane Controlled Trials Register, the Cochrane Library, Web of Science, EMBASE, and PubMed. The PICOS criteria was used to make sure the included studies fulfilled the inclusion criteria.

Results: Pooled data showed that there were no significant differences between the SHS and CCS groups for the Harris Hip Score. Significant differences were found between the SHS and CCS groups in terms of union time, postoperative complications, blood loss, operation time, incision length and length of hospital stay.

Conclusions: Although the SHS and CCS groups showed similar functional recovery in treatment of femoral neck fracture in terms of the Harris Hip Score, the SHS group showed fewer postoperative complications and faster union time for patients with femoral neck fractures. Therefore, compared with CCS, the use of SHS may be a more effective treatment of femoral neck fractures.

1. Introduction

Femoral neck fracture is considered a difficult fracture to treat and often gives rise to unsatisfactory treatment results [1]. According to epidemiological investigations, the annual number of hip fractures is expected to rise to 6.26 million by the year 2050 in the United States [2]. High energy trauma in young adults [3] and osteoporosis [4] in elderly individuals are the main risk factors of femoral neck fracture. Femoral neck fractures most commonly occur in individuals aged over 50 years, only 2%–3% of femoral neck fractures occur in the population below 50 years of age [5,6]. Non-union and osteonecrosis of the femoral head are 2 main complications in the population with femoral neck fractures [7].

Although multiple treatment protocols of femoral neck fracture such as arthroplasty and internal fixation have been proposed previously, preservation of autologous femoral head via surgical intervention using internal fixation is the treatment of choice, especially for younger patients or Garden's Type 1 and 2 fractures [8]. Usually, cannulated cancellous screws (CCS) or a sliding hip screw (SHS) are the mainstream internal fixations used for osteosynthesis of femoral neck fractures. Recently published biomechanical studies have shown that both CCS and SHS have achieved good biomechanical properties [9,10]. Similarly, clinical studies have also reported good results with CCS and SHS fixation, however, which method is actually superior is still to be determined. Gupta et al. demonstrated that there was no significant difference in clinical radiological outcome between CCS and SHS [11]. However, a study conducted by Siavashi et al. [12] reported that SHS is a better option compared with multiple cannulated screws for

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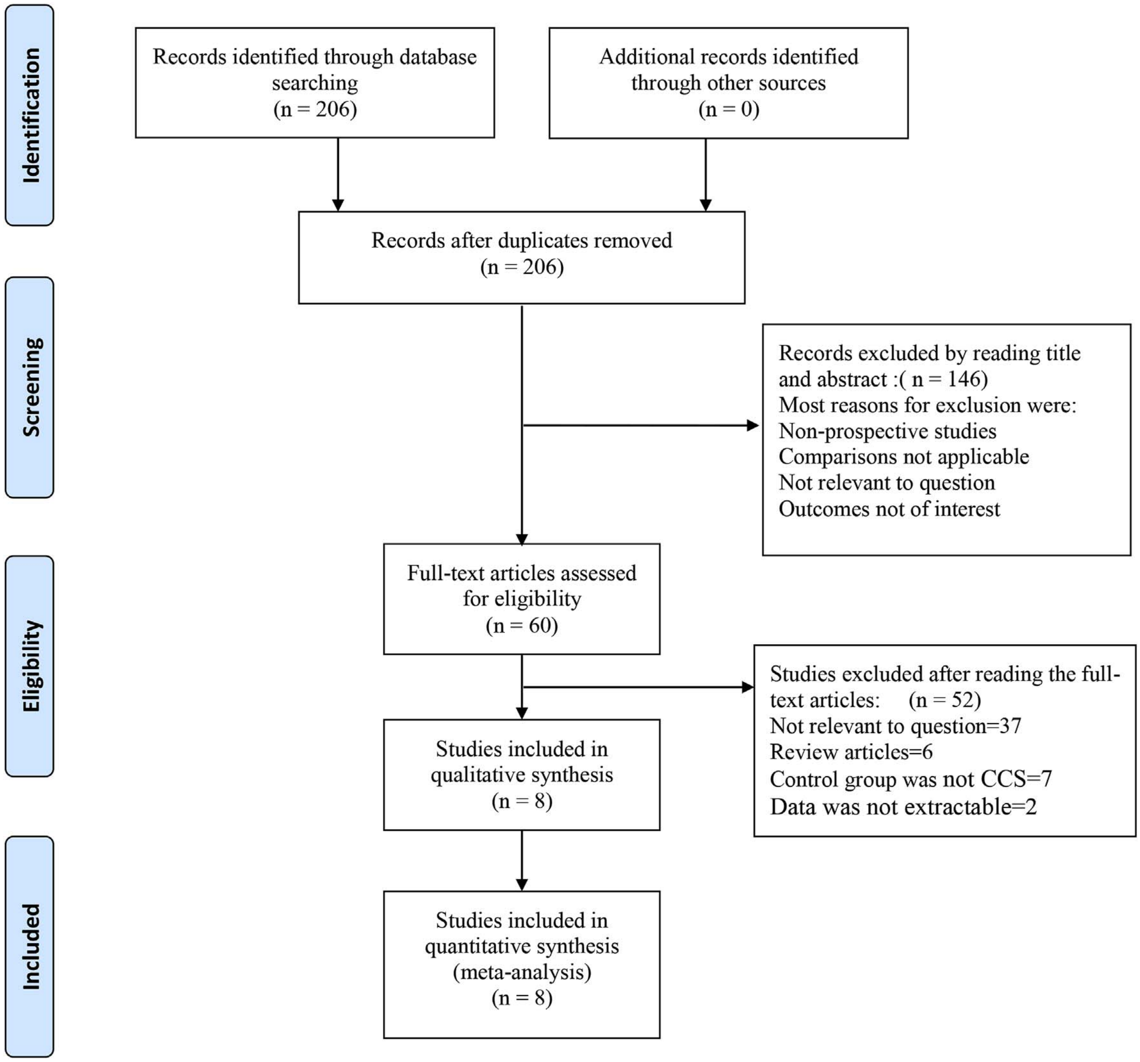

Fig. 1. Search results and selection procedure.

osteosynthesis. Therefore, it is necessary to integrate existing data using a meta-analysis to investigate the safety and effectiveness of CCS and SHS in the treatment of femoral neck fractures.

2. Materials and methods

2.1. Search strategy

We screened randomized controlled trials (RCTs) and prospective cohort studies by searching Google Scholar, the Cochrane Controlled Trials Register, the Cochrane Library, Web of Science, EMBASE, and PubMed from 1974 to August 2017. The search strategy is presented in Table S1. No language and publication restrictions were applied. The PRISMA guidelines and Cochrane Handbook were applied to assess the quality of the results published in all included studies to make sure the results of our meta-analysis were reliable and verifiable. A flow chart of the trial selection process is presented in Fig. 1. In addition, other databases were searched in detail according to the Cochrane Collaboration guidelines.

2.2. Inclusion criteria and exclusion criteria

Included studies were considered eligible if they met the following PICOS criteria:

Population: Patients with femoral neck fractures;
Intervention: SHS or SHS plus screw;
Comparator: CCS;
Outcomes: The primary outcome was the Harris Hip Score [13], which is an important indicator used to evaluate the hip joint function after hip surgery or arthroplasty. The secondary outcomes included blood loss (ml), operation time (minutes), incision length (cm), mean union time (months), postoperative complications and length of hospital stay (days);
Study design: Interventional studies (RCTs) and prospective cohort studies.

Only published clinical studies were included; the included studies were required to contain at least 1 outcome. Studies were required to have a follow-up rate of at least 80%, and at least 1 main patient-important outcome included. Two authors assessed eligible studies independently. In cases of disagreement, a consensus was reached through discussion between the 2 authors. Review articles, biomechanical studies, and unpublished RCTs were excluded.

2.3. Data extraction

We used a standard data extraction form to extract the relevant data from eligible articles. The extracted data included authors, study location, sample size, study design, publishing date, gender, population,

Table 1
Study quality assessment using Newcastle-Ottawa scale for cohort studies.

Studies/ year	Selection				comparability of cohorts on the basis of the design or analysis	Outcome			Total score
	representativeness of the exposed cohort	selection of the non-exposed cohort	ascertainment of exposure	outcome of interest was not present at start of study		assessment of outcome	was follow-up long enough for outcomes to occur?	adequacy of follow up of cohorts	
Chen 2011	*	*	–	*	** (age, gender, BMI etc)	*	*	*	8
Gupta 2016	*	*	*	*	* (age, gender, etc)	*	*	*	9
Hou 2015	*	*	–	*	*(age, gender, etc)	*	*	–	6
Kaplan 2012	*	*	*	*	* (age,etc)	*	*	*	8
Lee 2007	*	*	*	*	** (age, gender, etc)	*	*	*	9
Lee 2008	*	*	*	*	** (age, gender, etc)	*	–	*	8
Siavashi 2015	*	*	*	*	*(age, gender, etc)	*	*	*	8
Stiasny 2008	*	*	*	*	–	*	*	*	7

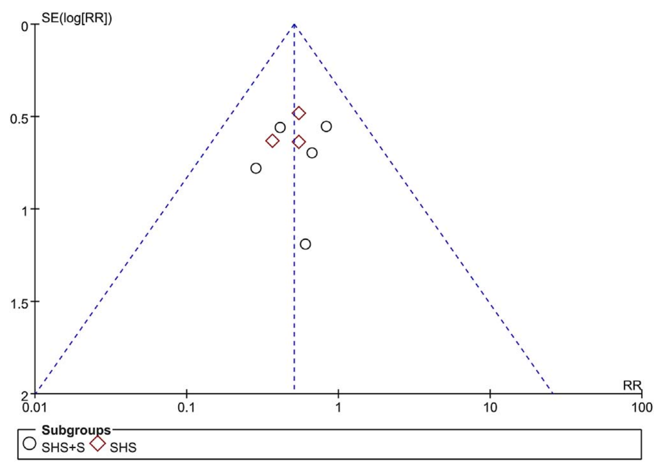

Fig. 2. A funnel plot shows the post-operative complications.

age, duration of follow-up, interventions and outcomes. If necessary, we contacted the corresponding authors of the included studies to make sure the information was integrated and to retrieve any missing data. Two reviewers extracted the data independently. If there were disagreements between two authors, consensus were reached through discussion.

2.4. Risk of bias assessment

According to the Cochrane Handbook for Systematic Reviews of Interventions [14,15], an 8-point Newcastle-Ottawa Scale [16] was used to assess the quality of prospective cohort studies as previous reported [17]. Studies achieving a score of greater than 5 points were considered to be of high quality [18]_. The risk of bias was evaluated by 8 items: 1) representativeness of the exposed cohort, 2) selection of the non-exposed cohort, 3) ascertainment of exposure, 4) demonstration that outcome of interest was not present at the start of the study, 5) comparability of cohorts on the basis of the design or analysis, 6) assessment of outcome, 7) sufficient follow-up time for outcomes to occur, 8) adequate follow-up of cohorts (Table 1).

2.5. Statistical analysis and data synthesis

Meta-analyses were performed with Review Manager Software for Windows (Version 5.3. Copenhagen: The Nordic Cochrane Centre, the Cochrane Collaboration, 2014) and STATA (Version 11.0). The mean difference (MD) or standard mean difference (SMD) was used to assess continuous outcomes with a 95% confidence interval [CI]. Relative risks (RR) with a 95% CI were used to assess dichotomous outcomes. The inverse variance and Mantel–Haenszel methods were used to combine separate statistics. If P values were less than 0.05, the results were considered statistically significant.

2.6. Investigation of heterogeneity

Statistical heterogeneity of the included studies was evaluated using the chi-square test in accordance with the values of P and I^2. If the values of $I^2 < 50\%$ and $P > 0.1$, the heterogeneity might not be important. A fixed-effects model was used to assess these outcomes. If I^2 was between 50% and 100%, it could represent substantial heterogeneity. We used random-effects model to evaluate these outcomes. Thresholds for the interpretation of I^2 can be misleading, since the importance of inconsistency depends on several factors. Therefore, subgroup analysis or sensitivity analysis was performed to interpret the potential source of heterogeneity.

2.7. Assessment of reporting bias

A funnel plot was used to assess the presence of reporting biases. We evaluated whether asymmetry was due to publication bias or to a relationship between trial size and effect size (Fig. 2).

2.8. Evaluation using GRADE

The GRADE (Grading of Recommendations Assessment, Development, and Evaluation) system was used to evaluate the quality of the evidence for each outcome [19]. GRADE profiler (Version 3.6.1) was used to evaluate the evidence of included outcomes. Initially, RCTs were considered as high confidence in an estimate of effect, and observational studies were considered as low confidence in an estimate of effect. Reasons that may decrease the level of confidence include risk of bias, inconsistency, indirectness, imprecision and publication bias. Reasons that may raise the level of confidence include large effect, dose response and all plausible residual confounding and bias. The GRADE evidence was divided into the following categories: (1) High-quality evidence, which indicated that further research was unlikely to change the confidence in an estimate of effect; (2) Moderate-quality evidence, which indicated that further research was likely to have an important impact on confidence in an estimate of effect and may change the estimate; (3) Low-quality evidence, which indicated that further research was likely to have an important impact on confidence in an estimate of

Table 2
The characteristics of included studies.

Studies	Cases	Mean Ages	Gender	Body weight	Fracture type(S/C)			Pauwels classification(S/C)			Garden's classification(S/C)			
	(S/C)	(Years)	(Male%)	(S/C)	Subcapital	Transcervical	Basicervical	I	II	III	Type 1	Type 2	Type 3	Type 4
Chen 2011	23/28	43.2/40.7	43.5/42.9	59.3/59.3	9/12	12/14	4/5	0/0	9/14	14/16	N/A	N/A	N/A	N/A
Gupta 2016	40/45	40.7/39.3	57.5/71.1	N/A	12/13	20/25	8/7	N/A	N/A	N/A	0/1	2/2	23/28	14/14
Hou 2015	36/31	43.7/43	67/71	N/A	7/6	39/25	0/0	4/2	8/6	24/23	N/A	N/A	N/A	N/A
Kaplan 2012	33/33	46/45	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	22/6	8/12	3/13	0/2
Lee 2007	25/32	74.6/72.8	48/53	64.3/69.5	N/A	N/A	N/A	6/8	16/21	3/3	N/A	N/A	N/A	N/A
Lee 2008	40/44	72.8/70.6	40/43	66.5/67.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Siavashi 2015	30/28	28/30	83/70	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stiasny 2008	42/70	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	23	38	27	26

S: Sliding hip screw, C: cannulated cancellous screws, N/A: not available.

effect and was likely to change the estimate; (4) Very low-quality evidence, which indicated that we were very uncertain about the results. The results of GRADE evidence are shown in Table 3.

3. Results

3.1. Search results

A total of 206 potentially eligible articles were identified in the databases. Of these, 146 records were excluded by reading the title and abstract. After reading the full text of all remaining articles in detail, 52 studies that did not meet the inclusion criteria were excluded. Finally, 8 prospective cohort studies with 594 patients that compared SHS and CCS in procedures were included. Cohort characteristics of the 8 studies were summarised in Table 2. All the included studies were prospective cohort studies. Although, one study [12] reported that the randomized method was used, the blinding method and allocation concealment were not performed. The sample size of each study ranged from 51 to 112. Three studies [11,20,21] reported the 3 different fracture types including subcapital type, transcervical type and basicervical type. Three studies [20–22] used the Pauwels classification to identify the fracture type and the Garden's classification was also reported in 3 studies [11,23,24].

4. Results of meta-analysis

4.1. Primary outcome

The Harris Hip Score was the primary outcome in our meta-analysis, which was used to evaluate the functional recovery of the hip joint. Seven studies [11,12,20–23,25] reported this score and the pooled data showed that there were no significant differences between the SHS and CCS group (MD = 2.28, 95%CI: [-0.37, 4.93], $P = 0.09$; Fig. 3). Subgroup analysis also failed to find any significant difference between the SHS plus screw (MD = 3.05, 95%CI: [-1.35, 7.45], $P = 0.17$; Fig. 3) and the SHS (MD = 1.22, 95%CI: [-0.69, 3.13], $P = 0.21$; Fig. 3) subgroup in our meta-analysis.

4.2. Secondary outcomes

The mean union time of fractures was also an important indicator. A meta-analysis was conducted in 5 studies [11,20–22,25] to assess the union time after surgery. Subgroup analysis showed that a significant difference was found between the SHS plus screw (MD = −10.93, 95%CI: [-15.78, −6.08], $P < 0.00001$; Fig. 4) and the SHS (MD = −4.9, 95%CI: [-9.46, −0.34], $P = 0.04$; Fig. 4) subgroup. The test for overall effect showed a significant difference between the SHS and the CCS group (MD = −7.73, 95%CI: [-11.05, −4.41], $P < 0.00001$; Fig. 4).

Table 3
The GRADE evidence quality for each outcome.

Quality assessment						
Participants (studies)	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Overall quality of evidence
Harris Hip Score (CRITICAL OUTCOME; Better indicated by lower values)						
468(7 studies)	serious	serious	no serious indirectness	no serious imprecision	undetected	⊕⊖⊖⊖, VERY LOW, due to risk of bias, inconsistency
Blood loss (IMPORTANT OUTCOME; Better indicated by lower values)						
269(4 studies)	serious	no serious inconsistency	no serious indirectness	serious	undetected	⊕⊖⊖⊖, VERY LOW, due to risk of bias, imprecision, dose-response gradient
Operation time (IMPORTANT OUTCOME; Better indicated by lower values)						
410(6 studies)	serious	no serious inconsistency	no serious indirectness	no serious imprecision	undetected	⊕⊖⊖⊖, VERY LOW, due to risk of bias
Incision length (NOT IMPORTANT OUTCOME; Better indicated by lower values)						
344(5 studies)	serious	no serious inconsistency	no serious indirectness	serious	undetected	⊕⊖⊖⊖, VERY LOW, due to risk of bias, imprecision
Length of hospital stay (NOT IMPORTANT OUTCOME; Better indicated by lower values)						
259(4 studies)	serious	no serious inconsistency	no serious indirectness	serious	undetected	⊕⊖⊖⊖, VERY LOW, due to risk of bias, imprecision
Mean union time (NOT IMPORTANT OUTCOME; Better indicated by lower values)						
344(5 studies)	serious	no serious inconsistency	no serious indirectness	serious	undetected	⊕⊖⊖⊖, VERY LOW, due to risk of bias, imprecision
Complication						
594(7 studies)	serious	no serious inconsistency	no serious indirectness	no serious imprecision	undetected	⊕⊖⊖⊖, VERY LOW, due to risk of bias

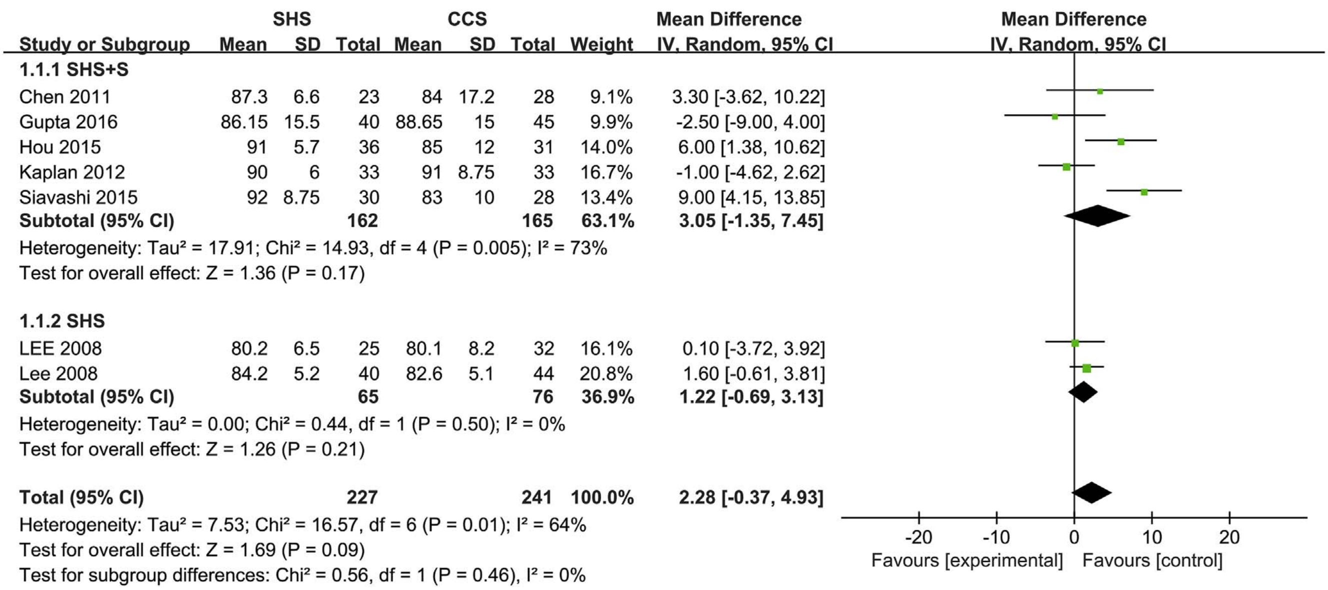

Fig. 3. A forest plot diagram shows the Harris Hip Score.

The presence of treatment complications was used to evaluate the safety of surgery, and all the included studies reported the rate of complications [11,12,20–25]. The subgroup analysis showed that a significant difference was found between the SHS plus screw (RR = 0.52, 95%CI: [0.29, 0.94], $P = 0.03$; Fig. 5) and SHS (RR = 0.49, 95%CI: [0.26, 0.93], $P = 0.03$; Fig. 5) subgroup. The test for overall effect showed a significant difference between the SHS and CCS group (RR = 0.52, 95%CI: [0.51, 0.78], $P = 0.002$; Fig. 5).

Data from 4 studies [11,20,21,23] reported blood loss during the operation. A significant difference was found between the SHS and CCS group (MD = 151.65, 95%CI: [52.49, 250.81], $P = 0.003$; Fig. 6).

Data were extracted from 6 studies [11,20–23,25] to evaluate the operation time. There were significant differences between the subgroup of SHS plus screw (MD = 21.83, 95%CI: [8.89, 34.77], $P = 0.0009$; Fig. 7) and SHS (MD = 5.33, 95%CI: [0.44, 10.21], $P = 0.03$; Fig. 7). The test for overall effect showed a significant difference between the SHS and CCS group (MD = 12.81, 95%CI: [6, 19.62], $P = 0.0002$; Fig. 7).

We extracted the incision length data from 6 studies [11,20–23,25]. A significant difference was found between the SHS plus screw (MD = 4.03, 95%CI: [2.03, 6.03], $P < 0.0001$; Fig. 8) and SHS (MD = 5.65, 95%CI: [4.96, 6.33], $P < 0.00001$; Fig. 8) subgroup. The test for overall effect also showed a significant difference between the SHS and CCS group (MD = 4.7, 95%CI: [2.75, 6.65], $P < 0.00001$; Fig. 8).

We extracted length of hospital stay data from 4 studies [20–22], [25]. Subgroup analysis was conducted to pool the data of the SHS plus screw (MD = 1.35, 95%CI: [0.75, 1.94], $P < 0.00001$; Fig. 9) and SHS subgroup (MD = 4.51, 95%CI: [3.38, 5.14], $P < 0.000001$; Fig. 9). The combined effect of 2 subgroups also showed a significant difference between the SHS and CCS group (MD = 2.93, 95%CI: [0.98, 4.89], $P = 0.003$; Fig. 9).

4.3. Results of reporting bias

Reporting bias was evaluated by funnel plot. The diagram was symmetrical, indicating low risk of publication bias. In addition, Egger's ($P = 0.12$) and Bagger's tests ($P = 0.133$) were performed to examine the reporting bias quantitatively, and no reporting bias was found in our meta-analysis.

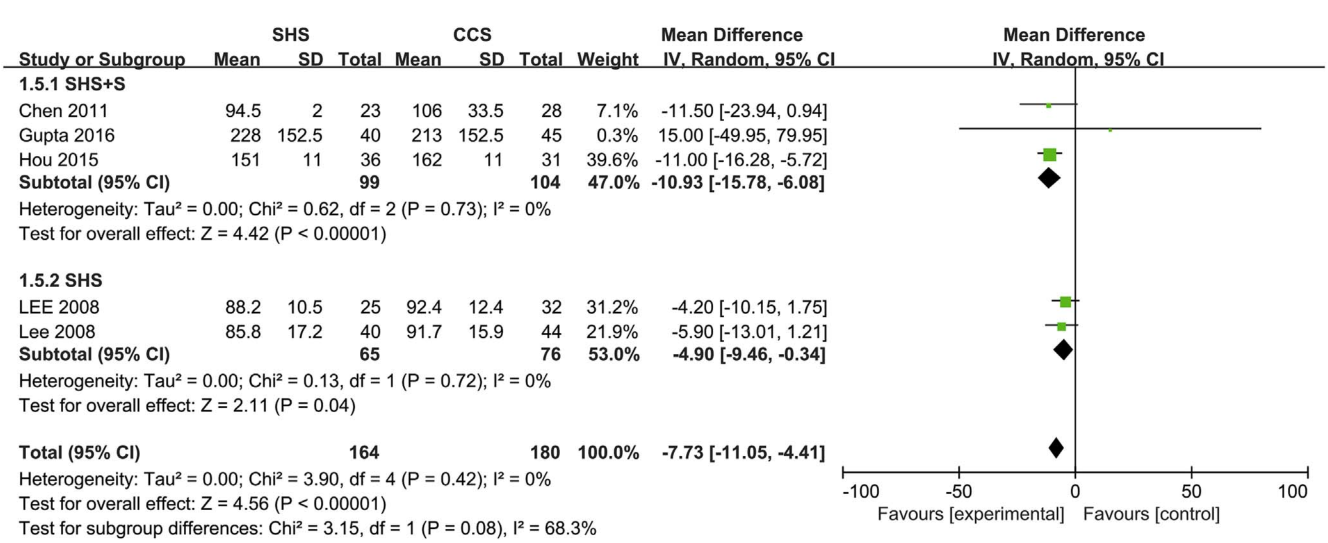

Fig. 4. A forest plot diagram shows the mean union time.

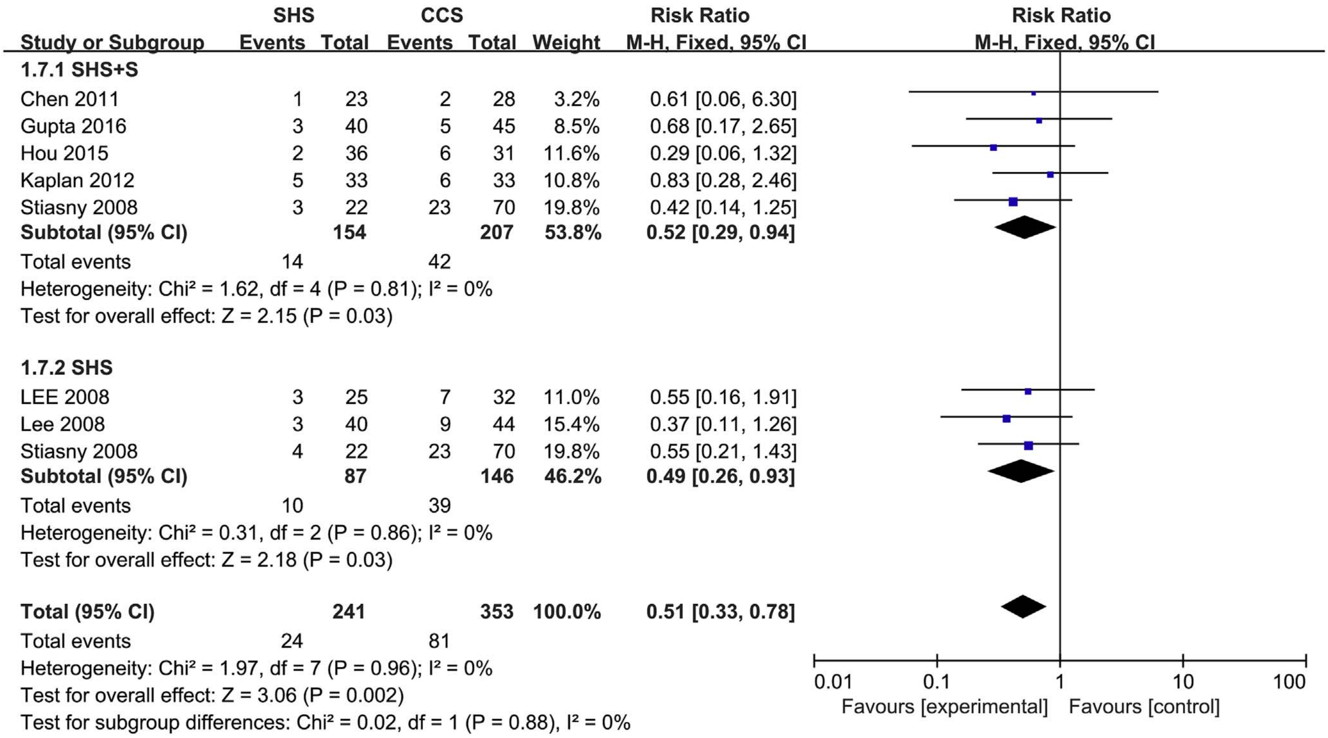

Fig. 5. A forest plot diagram shows post-operative complications.

4.4. GRADE evidence synthesis and recommendation strengths

The above outcomes in our meta-analysis were evaluated using the GRADE system. The level of evidence quality for each outcome was very low (Table 3). Therefore, the level of overall evidence quality was very low. This finding may lower the confidence in any recommendations.

5. Discussion

Factors that affected the results after fixation of femoral neck fractures primarily depend on the condition of the patients, degree of fracture displacement, adequacy of internal fixations, and quality of surgical reduction. Different methods of internal fixation have an effect on the rates of union and osteonecrosis in femoral neck fractures. However, few studies have reported the clinical results of using the SHS and CCS. Therefore, there was a need for an evidence base or recommendations to help surgeons make clinical decisions.

Our meta-analysis was conducted to analyse the clinical outcomes of two implants which have been traditionally used but have not been widely compared for femoral neck fractures. The pooled data analysis showed that the SHS was as effective as CCS in terms of the Harris Hip Score. Compared with the SHS group, the CCS group had less blood loss, shorter operation time, shorter length of hospital stay, and smaller incision length. Although statistical differences were found between the SHS and CCS groups in terms of blood loss, operation time, incision length, and length of hospital stay, no clinical significance was observed because of the small difference between the 2 groups. However, with regard to safety outcomes, the SHS group showed less postoperative complications and shorter union time of the fracture.

The Harris Hip Score was the primary outcome in our meta-analysis. Four parts including pain, function, deformity and range of motion were used to evaluate the quality of functional recovery after surgery. The results of the pooled data showed that SHS was no better than the CCS group in terms of this score. Kaplan et al. [23] also reported that no significant difference was found between the groups of patients treated with either SHS or CCS according to the Harris Hip Score. Another study conducted by Kuokkanen et al. [26] demonstrated that there were no significant differences in the score between the SHS and CCS groups in an undisplaced (Garden I) or minimally displaced (Garden II) femoral neck fracture. This was consistent with our findings. In our meta-analysis, we divided the included literature into 2 subgroups, one for the SHS and the other for the SHS plus screw group. Compared with the SHS, the SHS plus screw group showed better torsion resistance and similar axial failure load in biomechanical studies [27,28], and the clinical results were similar between the SHS group and SHS plus screw group in our meta-analysis. Results between the subgroup analysis and the test for overall effect were consistent. Moreover, some recently published studies such as that of Gupta et al. [11] have reported that there was no significant difference in clinic-radiological outcome

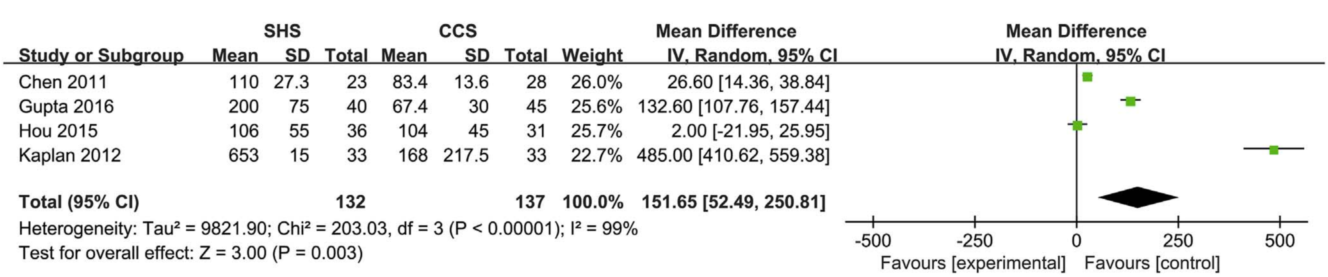

Fig. 6. A forest plot diagram shows the blood loss.

Study or Subgroup	SHS Mean	SHS SD	SHS Total	CCS Mean	CCS SD	CCS Total	Weight	Mean Difference IV, Random, 95% CI
1.3.1 SHS+S								
Chen 2011	48.3	5.3	23	44	3.6	28	20.9%	4.30 [1.76, 6.84]
Gupta 2016	111	48.75	40	61.6	22.5	45	9.5%	49.40 [32.92, 65.88]
Hou 2015	51	8.7	36	49	8.3	31	20.0%	2.00 [-2.08, 6.08]
Kaplan 2012	95	47.5	33	46	11	33	9.4%	49.00 [32.36, 65.64]
Subtotal (95% CI)			**132**			**137**	**59.8%**	**21.83 [8.89, 34.77]**
Heterogeneity: Tau² = 143.72; Chi² = 57.12, df = 3 (P < 0.00001); I² = 95%								
Test for overall effect: Z = 3.31 (P = 0.0009)								
1.3.2 SHS								
Lee 2008	43	9.6	40	40	5.8	44	20.4%	3.00 [-0.43, 6.43]
LEE 2008	48	8.8	25	40	7.4	32	19.8%	8.00 [3.70, 12.30]
Subtotal (95% CI)			**65**			**76**	**40.2%**	**5.33 [0.44, 10.21]**
Heterogeneity: Tau² = 8.56; Chi² = 3.17, df = 1 (P = 0.07); I² = 68%								
Test for overall effect: Z = 2.14 (P = 0.03)								
Total (95% CI)			**197**			**213**	**100.0%**	**12.81 [6.00, 19.62]**
Heterogeneity: Tau² = 56.09; Chi² = 60.31, df = 5 (P < 0.00001); I² = 92%								
Test for overall effect: Z = 3.69 (P = 0.0002)								
Test for subgroup differences: Chi² = 5.47, df = 1 (P = 0.02), I² = 81.7%								

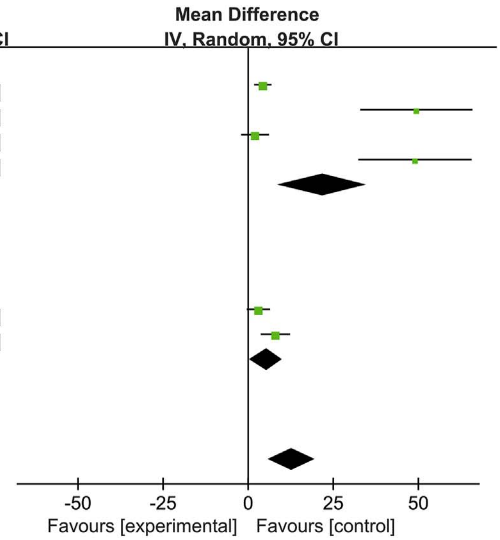

Fig. 7. A forest plot diagram shows the length of operation time.

between the 2 implants. Therefore, the SHS and CCS groups showed similar functional recovery in the treatment of femoral neck fracture.

The mean union time and postoperative complications were important indicators to evaluate the efficacy and safety of the surgery. A prospective study conducted by Lee et al. [25] reported that the union time in the SHS group was 85.8 ± 17.2 days compared with 91.7 ± 15.9 days in the CCS group. Chen et al. also demonstrated that the union time in the SHS group was shorter than the CCS group [20]. Our meta-analysis showed that union time was shorter in patients with femoral neck fracture treated with SHS. Moreover, fewer postoperative complications were found in the SHS group. Siavashi et al. [12] reported that there was no fixation failure in the SHS group but there were 5 fixation failures in the CCS group, and there was a significant difference between the groups ($P < 0.001$). The results of our meta-analysis were in consensus with the results of the findings mentioned above.

All the included studies reported that blood loss in the SHS group was more than the CCS group. The amount of blood loss was closely related to the degree of postoperative functional recovery. Gupta et al. [11] showed that the mean intraoperative blood loss in the SHS and CCS groups was 67.4 ml versus 200 ml respectively, and a significant difference was found between the 2 groups ($P < 0.001$). Similarly, another study also reported that less blood loss was observed in the CCS group when compared with SHS group [23]. Maybe the incision length and operation time were important factors that affected the blood loss. In our pooled data analysis, the CCS group showed a smaller incision length and less operation time. Lee et al. [22] reported that the mean incision length was 2.7 cm and 8.4 cm in the CCS group and SHS group respectively, Further, the operation time in the SHS group was longer than the CCS group. Length of hospital stay was also affected by these factors including blood loss and incision length. Although a statistical difference was found in the length of hospital stay, no clinical significance was observed due to the small difference between the SHS and CCS groups.

The GRADE system was used to assess the quality of evidence in our meta-analysis. All the included studies were cohort studies and showed low quality evidence at the beginning. However, because of risk of bias and inconsistency, the included cohort studies showed low quality of evidence. Moreover, 3 categories of items were used to upgrade the quality of evidence: a large effect, plausible confounding which would change the effect, and dose response gradient. The above factors of GRADE evidence quality did not account for the upgraded quality of evidence. Therefore, the overall GRADE evidence quality was very low, and so, we should be cautious about the results of the analysis.

Study or Subgroup	SHS Mean	SHS SD	SHS Total	CCS Mean	CCS SD	CCS Total	Weight	Mean Difference IV, Random, 95% CI
1.4.1 SHS+S								
Chen 2011	5.1	0.3	23	3.1	0.2	28	20.3%	2.00 [1.86, 2.14]
Gupta 2016	12.6	3	40	3.9	0.75	45	19.4%	8.70 [7.74, 9.66]
Hou 2015	5	0.86	36	3.3	0.57	31	20.2%	1.70 [1.35, 2.05]
Subtotal (95% CI)			**99**			**104**	**59.9%**	**4.03 [2.03, 6.03]**
Heterogeneity: Tau² = 3.03; Chi² = 190.37, df = 2 (P < 0.00001); I² = 99%								
Test for overall effect: Z = 3.95 (P < 0.0001)								
1.4.2 SHS								
LEE 2008	8.7	1.2	25	2.7	0.42	32	20.1%	6.00 [5.51, 6.49]
Lee 2008	8.4	1.45	40	3.1	0.42	44	20.1%	5.30 [4.83, 5.77]
Subtotal (95% CI)			**65**			**76**	**40.1%**	**5.65 [4.96, 6.33]**
Heterogeneity: Tau² = 0.19; Chi² = 4.09, df = 1 (P = 0.04); I² = 76%								
Test for overall effect: Z = 16.13 (P < 0.00001)								
Total (95% CI)			**164**			**180**	**100.0%**	**4.70 [2.75, 6.65]**
Heterogeneity: Tau² = 4.86; Chi² = 561.44, df = 4 (P < 0.00001); I² = 99%								
Test for overall effect: Z = 4.73 (P < 0.00001)								
Test for subgroup differences: Chi² = 2.25, df = 1 (P = 0.13), I² = 55.6%								

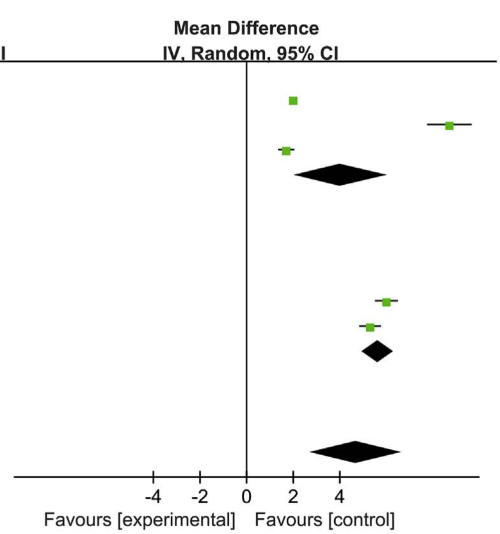

Fig. 8. A forest plot diagram shows the incision length.

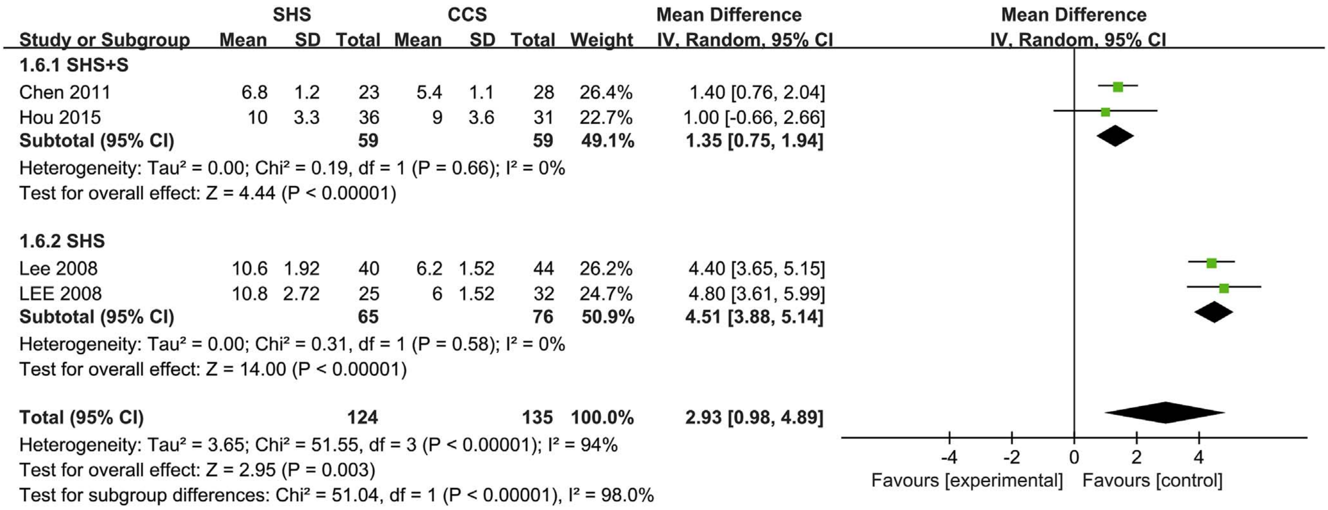

Fig. 9. A forest plot diagram shows the length of hospital stay.

Our systematic review has the following limitations: (1) Only 8 prospective cohort studies assessing a total of 594 patients were included in our meta-analysis; if more RCTs had been included, the statistical efficacy of our analysis would increase. (2) The patient follow-up period was different in some included trials, and therefore we could not be certain of the exact time of follow-up to obtain statistical data. (3) Heterogeneity among the included studies was unavoidable because different surgeons performed the surgery, and for the patients there were gender differences, racial differences, age differences, and follow-up times. In addition, the interventional group contained 2 types of fixations (SHS and SHS plus screw). Therefore, subgroup analysis was performed in our meta-analysis to clarify the cause of inequality and bias.(4) Two statistical methods including SHS plus screw and SHS alone were used in the included studies to perform the meta-analysis. Although subgroup analysis was used to analyse the data separately, heterogeneity was inevitable for the overall power. (5) Although the Cochrane Handbook for Systematic Reviews of Interventions was used to carefully evaluate the quality of included studies, information bias could have existed due to objective judgments. To the best of our knowledge, this study is the first systematic review to evaluate the quality of the evidence comparing SHS and CCS for femoral neck fracture. Available articles were stringently screened prior to inclusion. The PRISMA guidelines and Cochrane Handbook were applied to assess the quality of the results published in all included studies.

6. Conclusions

Although the SHS and CCS groups showed similar functional recovery in treatment of femoral neck fracture in terms of the Harris Hip Score, the SHS group showed fewer postoperative complications and faster union time for patients with femoral neck fractures. Therefore, compared with CCS, the use of SHS may be a more effective treatment of femoral neck fractures.

Ethical approval

This article is not involved in ethical requirements.

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Author contribution

M.J. K: conceived of and designed the study, collected and analysed the data, and wrote the paper. J.X.M, C.H and Z.R.F: collected and analysed the data. X.L.M: designed the study and proofread the manuscript. H.T.C, Y.L.Z, L.K.Z and X. F: revised the draft and generated figures. All authors reviewed and approved the manuscript.

Conflicts of interest

Each author certifies that he has no commercial associations that might pose a conflict of interest with the submitted article.

Trial registry number

The study we designed is not an RCT.

Guarantor

Xin-long Ma.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.ijsu.2018.01.050.

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