# World Journal of *Clinical Cases*

World J Clin Cases 2022 November 6; 10(31): 11214-11664





Published by Baishideng Publishing Group Inc

W J C C World Journal of Clinical Cases

ContentsThrice Monthly Volume 10 Number 31 November 6, 20										
	REVIEW									
11214	Diabetes and skin cancers: Risk factors, molecular mechanisms and impact on prognosis									
	Dobrică EC, Banciu ML, Kipkorir V, Khazeei Tabari MA, Cox MJ, Simhachalam Kutikuppala LV, Găman MA									
11226	Endocrine disruptor chemicals as obesogen and diabetogen: Clinical and mechanistic evidence									
11220	Kurşunoğlu NE, Sarer Yurekli BP									
11240	Intestinal microbiota in the treatment of metabolically associated fatty liver disease									
	Wang JS, Liu JC									
	MINIREVIEWS									
11252	Lactation mastitis: Promising alternative indicators for early diagnosis									
	Huang Q, Zheng XM, Zhang ML, Ning P, Wu MJ									
11260	Clinical challenges of glycemic control in the intensive care unit: A narrative review									
	Sreedharan R, Martini A, Das G, Aftab N, Khanna S, Ruetzler K									
11273	Concise review on short howel syndrome. Eticlogy, nothen hysiology, and management									
112/3	Concise review on short bowel syndrome: Etiology, pathophysiology, and management Lakkasani S, Seth D, Khokhar I, Touza M, Dacosta TJ									
11283	Role of nickel-regulated small RNA in modulation of <i>Helicobacter pylori</i> virulence factors									
	Freire de Melo F, Marques HS, Fellipe Bueno Lemos F, Silva Luz M, Rocha Pinheiro SL, de Carvalho LS, Souza CL, Oliveira MV									
11292	Surgical intervention for acute pancreatitis in the COVID-19 era									
112/2	Su YJ, Chen TH									
	ORIGINAL ARTICLE									
	Clinical and Translational Research									
11299	Screening of traditional Chinese medicine monomers as ribonucleotide reductase M2 inhibitors for tumor treatment									
	Qin YY, Feng S, Zhang XD, Peng B									
	Case Control Study									
11313	Covered transjugular intrahepatic portosystemic stent-shunt <i>vs</i> large volume paracentesis in patients with cirrhosis: A real-world propensity score-matched study									
	Dhaliwal A Merhzad H Karkhanis S Tripathi D									

Dhaliwal A, Merhzad H, Karkhanis S, Tripathi D



Contor	World Journal of Clinical Cases
Conter	Thrice Monthly Volume 10 Number 31 November 6, 2022
	Retrospective Cohort Study
11325	Endoscopic submucosal tunnel dissection for early esophageal squamous cell carcinoma in patients with cirrhosis: A propensity score analysis
	Zhu LL, Liu LX, Wu JC, Gan T, Yang JL
	Retrospective Study
11338	Nomogram for predicting overall survival in Chinese triple-negative breast cancer patients after surgery
	Lin WX, Xie YN, Chen YK, Cai JH, Zou J, Zheng JH, Liu YY, Li ZY, Chen YX
11349	Early patellar tendon rupture after total knee arthroplasty: A direct repair method
	Li TJ, Sun JY, Du YQ, Shen JM, Zhang BH, Zhou YG
11358	Coxsackievirus A6 was the most common enterovirus serotype causing hand, foot, and mouth disease in Shiyan City, central China
	Li JF, Zhang CJ, Li YW, Li C, Zhang SC, Wang SS, Jiang Y, Luo XB, Liao XJ, Wu SX, Lin L
11371	Dynamic changes of estimated glomerular filtration rate are conversely related to triglyceride in non- overweight patients
	Liu SQ, Zhang XJ, Xue Y, Huang R, Wang J, Wu C, He YS, Pan YR, Liu LG
11381	C-reactive protein as a non-linear predictor of prolonged length of intensive care unit stay after gastrointestinal cancer surgery
	Yan YM, Gao J, Jin PL, Lu JJ, Yu ZH, Hu Y
	Clinical Trials Study
11391	Dan Bai Xiao Formula combined with glucocorticoids and cyclophosphamide for pediatric lupus nephritis: A pilot prospective study
	Cao TT, Chen L, Zhen XF, Zhao GJ, Zhang HF, Hu Y
	Observational Study
11403	Relationship between lipids and sleep apnea: Mendelian randomization analysis
	Zhang LP, Zhang XX
11411	Efficacy and safety profile of two-dose SARS-CoV-2 vaccines in cancer patients: An observational study in China
	Cai SW, Chen JY, Wan R, Pan DJ, Yang WL, Zhou RG
	Prospective Study
11419	Pressure changes in tapered and cylindrical shaped cuff after extension of head and neck: A randomized controlled trial
	Seol G, Jin J, Oh J, Byun SH, Jeon Y
	Randomized Controlled Trial
11427	Effect of intradermal needle therapy at combined acupoints on patients' gastrointestinal function following surgery for gastrointestinal tumors
	Guo M, Wang M, Chen LL, Wei FJ, Li JE, Lu QX, Zhang L, Yang HX



#### Contents

#### Thrice Monthly Volume 10 Number 31 November 6, 2022

#### SYSTEMATIC REVIEWS

11442 Video-assisted bystander cardiopulmonary resuscitation improves the quality of chest compressions during simulated cardiac arrests: A systemic review and meta-analysis

Pan DF, Li ZJ, Ji XZ, Yang LT, Liang PF

#### **META-ANALYSIS**

11454 Efficacy of the femoral neck system in femoral neck fracture treatment in adults: A systematic review and meta-analysis

Wu ZF, Luo ZH, Hu LC, Luo YW

11466 Prevalence of polymyxin-induced nephrotoxicity and its predictors in critically ill adult patients: A metaanalysis

Wang JL, Xiang BX, Song XL, Que RM, Zuo XC, Xie YL

#### **CASE REPORT**

11486	Novel compound heterozygous variants in the LHX3 gene caused combined pituitary hormone deficiency: A case report
	Lin SZ, Ma QJ, Pang QM, Chen QD, Wang WQ, Li JY, Zhang SL
11493	Fatal bleeding due to an aorto-esophageal fistula: A case report and literature review
	Ćeranić D, Nikolić S, Lučev J, Slanič A, Bujas T, Ocepek A, Skok P
11500	Tolvaptan ameliorated kidney function for one elderly autosomal dominant polycystic kidney disease patient: A case report
	Zhou L, Tian Y, Ma L, Li WG
11508	Extensive right coronary artery thrombosis in a patient with COVID-19: A case report
	Dall'Orto CC, Lopes RPF, Cancela MT, de Sales Padilha C, Pinto Filho GV, da Silva MR
11517	Yokoyama procedure for a woman with heavy eye syndrome who underwent multiple recession-resection operations: A case report
	Yao Z, Jiang WL, Yang X
11523	Rectal cancer combined with abdominal tuberculosis: A case report
	Liu PG, Chen XF, Feng PF
11529	Malignant obstruction in the ileocecal region treated by self-expandable stent placement under the fluoroscopic guidance: A case report
	Wu Y, Li X, Xiong F, Bao WD, Dai YZ, Yue LJ, Liu Y
11536	Granulocytic sarcoma with long spinal cord compression: A case report
	Shao YD, Wang XH, Sun L, Cui XG
11542	Aortic dissection with epileptic seizure: A case report
	Zheng B, Huang XQ, Chen Z, Wang J, Gu GF, Luo XJ



	World Journal of Clinical Cases
Conter	Thrice Monthly Volume 10 Number 31 November 6, 2022
11549	Multiple bilateral and symmetric C1-2 ganglioneuromas: A case report
	Wang S, Ma JX, Zheng L, Sun ST, Xiang LB, Chen Y
11555	Acute myocardial infarction due to Kounis syndrome: A case report
	Xu GZ, Wang G
11561	Surgical excision of a large retroperitoneal lymphangioma: A case report
	Park JH, Lee D, Maeng YH, Chang WB
11567	Mass-like extragonadal endometriosis associated malignant transformation in the pelvis: A rare case report
	Chen P, Deng Y, Wang QQ, Xu HW
11574	Gastric ulcer treated using an elastic traction ring combined with clip: A case report
	Pang F, Song YJ, Sikong YH, Zhang AJ, Zuo XL, Li RY
11579	Novel liver vein deprivation technique that promotes increased residual liver volume (with video): A case report
	Wu G, Jiang JP, Cheng DH, Yang C, Liao DX, Liao YB, Lau WY, Zhang Y
11585	Linear porokeratosis of the foot with dermoscopic manifestations: A case report
	Yang J, Du YQ, Fang XY, Li B, Xi ZQ, Feng WL
11590	Primary hepatic angiosarcoma: A case report
	Wang J, Sun LT
11597	Hemorrhagic shock due to ruptured lower limb vascular malformation in a neurofibromatosis type 1 patient: A case report
	Shen LP, Jin G, Zhu RT, Jiang HT
11607	Gastric linitis plastica with autoimmune pancreatitis diagnosed by an endoscopic ultrasonography-guided fine-needle biopsy: A case report
	Sato R, Matsumoto K, Kanzaki H, Matsumi A, Miyamoto K, Morimoto K, Terasawa H, Fujii Y, Yamazaki T, Uchida D, Tsutsumi K, Horiguchi S, Kato H
11617	Favorable response of primary pulmonary lymphoepithelioma-like carcinoma to sintilimab combined with chemotherapy: A case report
	Zeng SY, Yuan J, Lv M
11625	Benign paroxysmal positional vertigo with congenital nystagmus: A case report
	Li GF, Wang YT, Lu XG, Liu M, Liu CB, Wang CH
11630	Secondary craniofacial necrotizing fasciitis from a distant septic emboli: A case report
	Lee DW, Kwak SH, Choi HJ
11638	Pancreatic paraganglioma with multiple lymph node metastases found by spectral computed tomography: A case report and review of the literature
	Li T, Yi RQ, Xie G, Wang DN, Ren YT, Li K



Conter	World Journal of Clinical Cases
Conten	Thrice Monthly Volume 10 Number 31 November 6, 2022
11646	Apnea caused by retrobulbar anesthesia: A case report
	Wang YL, Lan GR, Zou X, Wang EQ, Dai RP, Chen YX
11652	Unexplained septic shock after colonoscopy with polyethylene glycol preparation in a young adult: A case report
	Song JJ, Wu CJ, Dong YY, Ma C, Gu Q
11658	Metachronous isolated penile metastasis from sigmoid colon adenocarcinoma: A case report

Yin GL, Zhu JB, Fu CL, Ding RL, Zhang JM, Lin Q



#### Contents

Thrice Monthly Volume 10 Number 31 November 6, 2022

#### **ABOUT COVER**

Editorial Board Member of World Journal of Clinical Cases, Muhammad Hamdan Gul, MD, Assistant Professor, Department of Internal Medicine, University of Kentucky, Chicago, IL 60657, United States. hamdan3802@hotmail.com

#### **AIMS AND SCOPE**

The primary aim of World Journal of Clinical Cases (WJCC, World J Clin Cases) is to provide scholars and readers from various fields of clinical medicine with a platform to publish high-quality clinical research articles and communicate their research findings online.

WJCC mainly publishes articles reporting research results and findings obtained in the field of clinical medicine and covering a wide range of topics, including case control studies, retrospective cohort studies, retrospective studies, clinical trials studies, observational studies, prospective studies, randomized controlled trials, randomized clinical trials, systematic reviews, meta-analysis, and case reports.

#### **INDEXING/ABSTRACTING**

The WJCC is now abstracted and indexed in Science Citation Index Expanded (SCIE, also known as SciSearch®), Journal Citation Reports/Science Edition, Current Contents®/Clinical Medicine, PubMed, PubMed Central, Scopus, Reference Citation Analysis, China National Knowledge Infrastructure, China Science and Technology Journal Database, and Superstar Journals Database. The 2022 Edition of Journal Citation Reports® cites the 2021 impact factor (IF) for WJCC as 1.534; IF without journal self cites: 1.491; 5-year IF: 1.599; Journal Citation Indicator: 0.28; Ranking: 135 among 172 journals in medicine, general and internal; and Quartile category: Q4. The WJCC's CiteScore for 2021 is 1.2 and Scopus CiteScore rank 2021: General Medicine is 443/826.

#### **RESPONSIBLE EDITORS FOR THIS ISSUE**

Production Editor: Xu Guo; Production Department Director: Xiang Li; Editorial Office Director: Jin-Lei Wang.

NAME OF JOURNAL	INSTRUCTIONS TO AUTHORS
World Journal of Clinical Cases	https://www.wignet.com/bpg/gerinfo/204
<b>ISSN</b>	GUIDELINES FOR ETHICS DOCUMENTS
ISSN 2307-8960 (online)	https://www.wjgnet.com/bpg/GerInfo/287
LAUNCH DATE	GUIDELINES FOR NON-NATIVE SPEAKERS OF ENGLISH
April 16, 2013	https://www.wignet.com/bpg/gerinfo/240
FREQUENCY	PUBLICATION ETHICS
Thrice Monthly	https://www.wjgnet.com/bpg/GerInfo/288
<b>EDITORS-IN-CHIEF</b> Bao-Gan Peng, Jerzy Tadeusz Chudek, George Kontogeorgos, Maurizio Serati, Ja Hyeon Ku	PUBLICATION MISCONDUCT https://www.wjgnet.com/bpg/gerinfo/208
EDITORIAL BOARD MEMBERS	ARTICLE PROCESSING CHARGE
https://www.wjgnet.com/2307-8960/editorialboard.htm	https://www.wjgnet.com/bpg/gerinfo/242
PUBLICATION DATE November 6, 2022	STEPS FOR SUBMITTING MANUSCRIPTS https://www.wjgnet.com/bpg/GerInfo/239
COPYRIGHT	ONLINE SUBMISSION
© 2022 Baishideng Publishing Group Inc	https://www.f6publishing.com

© 2022 Baishideng Publishing Group Inc. All rights reserved. 7041 Koll Center Parkway, Suite 160, Pleasanton, CA 94566, USA E-mail: bpgoffice@wjgnet.com https://www.wjgnet.com



W J C C World Journal C Clinical Cases

# World Journal of

Submit a Manuscript: https://www.f6publishing.com

World J Clin Cases 2022 November 6; 10(31): 11454-11465

DOI: 10.12998/wjcc.v10.i31.11454

ISSN 2307-8960 (online)

META-ANALYSIS

## Efficacy of the femoral neck system in femoral neck fracture treatment in adults: A systematic review and meta-analysis

Zhi-Fang Wu, Zi-Heng Luo, Liu-Chao Hu, Yi-Wen Luo

Specialty type: Surgery

Provenance and peer review: Unsolicited article; Externally peer reviewed.

Peer-review model: Single blind

#### Peer-review report's scientific quality classification

Grade A (Excellent): 0 Grade B (Very good): 0 Grade C (Good): C, C, C Grade D (Fair): 0 Grade E (Poor): 0

P-Reviewer: Baek SH, South Korea; Kazeminia M, Iran; Virarkar M, United States

Received: April 25, 2022 Peer-review started: April 25, 2022 First decision: June 27, 2022 Revised: July 19, 2022 Accepted: October 9, 2022 Article in press: October 9, 2022 Published online: November 6, 2022



Zhi-Fang Wu, Zi-Heng Luo, Liu-Chao Hu, Yi-Wen Luo, Department of Orthopedics and Trauma, The Third Affiliated Hospital of Guangzhou University of Chinese Medicine (Guangdong Research Institute for Orthopedics and Traumatology of Chinese Medicine), Guangzhou 510378, Guangdong Province, China

Corresponding author: Yi-Wen Luo, PhD, Chief Doctor, Department of Orthopedics and Trauma, The Third Affiliated Hospital of Guangzhou University of Chinese Medicine (Guangdong Research Institute for Orthopedics and Traumatology of Chinese Medicine), No. 261 Longxi Road, Liwan District, Guangzhou 510378, Guangdong Province, China. gzzyydxlyw@126.com

#### Abstract

#### BACKGROUND

Controversy remains around the available choices for the internal fixation of a femoral neck fracture. The femoral neck system (FNS) was developed in 2018 and has been widely applied since then as it can provide rigid fixation stability with less damage to the bone mass around the fracture. However, no systematic reviews and meta-analyses have investigated the efficacy of the FNS in comparison with that of traditional internal fixation in the treatment of femoral fractures.

#### AIM

To assess the efficacy of the FNS in comparison with that of cannulated compression screws (CCS) in the treatment of femoral fractures through systematic review and meta-analysis.

#### **METHODS**

Five electronic databases (PubMed, Embase, Cochrane Central Register of Controlled Trials, China National Knowledge Infrastructure, and Wanfang) were searched from the earliest publication date to December 31, 2021. Reference Citation Analysis (https://www.referencecitationanalysis.com/) was used to check the results and further analyze the related articles. Controlled trials were included if the FNS was applied for the femoral neck fracture in adults and if it was compared with CCS for the achievement of internal fixation. The measurement outcomes included the required operation time, observed patient's blood loss, extent of fracture healing, patient's Harris Hip score (HHS) at the last follow-up, and records of any complications (such as failure of internal fixation, femoral neck shortness, avascular necrosis of the femoral head, and delayed union

or nonunion).

#### RESULTS

Ten retrospective controlled studies (involving 711 participants) were included in this metaanalysis. The meta-analysis showed that compared with CCS, use of the FNS could not decrease the operation time [standardized mean difference (SMD): -0.38, 95% confidence interval (CI): -0.98 to 0.22, P = 0.21,  $l^2 = 93\%$ ), but it could increase the intraoperative blood loss (SMD: 0.59, 95% CI: 0.15 to 1.03, P = 0.009,  $l^2 = 81\%$ ). The pooled results also showed that compared with CCS, the FNS could better promote fracture healing (SMD: -0.97, 95% CI: -1.65 to -0.30, P = 0.005,  $l^2 = 91\%$ ), improve the HHS at the last follow-up (SMD: 0.76, 95% CI: 0.31 to 1.21, P = 0.0009,  $l^2 = 84\%$ ), and reduce the chances of developing femoral neck shortness (OR: 0.29, 95% CI: 0.14 to 0.61, P = 0.001,  $l^2$ = 0%) and delayed union or nonunion (OR: 0.47, 95% CI: 0.30 to 0.73, P = 0.001;  $l^2 = 0\%$ ) in adult patients with femoral neck fractures. However, there was no statistically significant difference between the FNS and CCS in terms of failure of internal fixation (OR: 0.49, 95% CI: 0.23 to 1.06, P =0.07,  $l^2 = 0\%$ ) and avascular necrosis of the femoral head (OR: 0.46, 95% CI: 0.20 to 1.10, P = 0.08,  $l^2 =$ 0%).

#### CONCLUSION

Compared with CCS, the FNS could decrease the chances of developing femoral neck shortness and delayed union or nonunion in adults with femoral neck fractures. Simultaneously, it could accelerate fracture healing and improve the HHS in these patients.

Key Words: Femoral neck fracture; Internal fixators; Treatment outcome; Systematic review; Meta-analysis

©The Author(s) 2022. Published by Baishideng Publishing Group Inc. All rights reserved.

**Core Tip:** This study aimed to investigate the efficacy of the femoral neck system (FNS) in comparison with cannulated compression screws (CCS) in the treatment of femoral neck fractures in adults. A total of 10 studies involving 711 participants were included. This study revealed that compared with CCS, the FNS could decrease the chances of developing short femoral neck and delayed union or nonunion as well as accelerate fracture healing and improve the Harris Hip score at the last follow-up in adult patients with femoral neck fractures. These results could help in the selection of the most appropriate treatment for patients with femoral neck fractures.

Citation: Wu ZF, Luo ZH, Hu LC, Luo YW. Efficacy of the femoral neck system in femoral neck fracture treatment in adults: A systematic review and meta-analysis. *World J Clin Cases* 2022; 10(31): 11454-11465 URL: https://www.wjgnet.com/2307-8960/full/v10/i31/11454.htm DOI: https://dx.doi.org/10.12998/wjcc.v10.i31.11454

#### INTRODUCTION

Femoral neck fracture is one of the most common traumatic injuries, and it is believed to occur in 150000 patients per year in the United States (US) alone[1]. The incidence of this type of injury is increasing among elderly patients, and it is expected to exceed 250000 cases per year in the next 25 years, thereby accounting for approximately 50% of hip fracture cases in the US[2,3]. A femoral neck fracture can seriously affect the patient's quality of life and increase the risk of severe complications[4].

Patients with femoral neck fractures tend to be treated surgically. Most elderly patients with displaced femoral fractures receive the golden standard treatment involving hemiarthroplasty or total hip arthroplasty[5]. However, there remains controversy regarding the choice of treatment for nondisplaced femoral neck fractures in the elderly and younger adult patients. Recent studies have demonstrated that the issues associated with existing internal fixation methods, such as the lack of an antirotation force, nail back, and loosening, can have a negative impact on the offset of femoral neck fractures, which may ultimately necessitate reoperation[6,7]. Several commonly used implants for establishing internal fixation in the femoral neck fracture include cannulate screws, dynamic hip screws, compression locking plates, and other newer plate systems.

In recent years, the femoral neck system (FNS; DePuy-Synthes, Johnson & Johnson Medical Devices, New Brunswick, NJ, United States) has been developed for the treatment of femoral neck fractures. The FNS requires minimal invasion and exerts antirotation, antisliding, and antishearing forces. However, there is insufficient evidence on the efficacy of the FNS in the treatment of femoral fractures when

compared with traditional internal fixation methods. The aim of this study was to provide a systematic review of the literature in order to examine the efficacy of the FNS in the treatment of femoral neck fractures in adults.

#### MATERIALS AND METHODS

#### Search strategy

Five electronic databases (PubMed, Embase, Cochrane Central Register of Controlled Trials, China National Knowledge Infrastructure, and Wanfang) were searched from the earliest publication date to December 31, 2021. The PubMed search strategy was as follows: (((((femoral neck fracture[Title/Abstract])) OR (femoral neck fractures[Title/Abstract])) OR (femur neck fractures[Title/Abstract])) OR (femur neck fractures[Title/Abstract])) OR (femur neck fractures[Title/Abstract])) OR (femural neck fractures[Title/Abstract])) OR ("femoral neck fractures" [MeSH])) AND ((femoral neck system[Title/Abstract])) OR ("femoral neck fractures" [MeSH])) AND ((internal fixation[Title/Abstract]) OR (implant[Title/Abstract])). Additionally, references of the included studies were screened to collect as many relevant studies as possible. There were no restrictions on the language of the screened studies. The search was independently conducted by two authors. Any cases of disagreements were resolved by the third author. Reference Citation Analysis (https://www.referencecitationanalysis.com/) was used to check the results and further analyze the related articles.

#### Study selection

**Inclusion criteria:** A study was included if: (1) It was a randomized controlled trial (RCT) or a controlled clinical trial; (2) It discussed patients aged > 18 years with femoral neck fractures; (3) The patients were treated with internal fixation; (4) There was a comparison between the FNS and cannulated compression screws (CCS); and (5) It was available as a full-text article.

**Exclusion criteria:** A study was excluded if: (1) The patients did not suffer from a femoral neck fracture; (2) It was not a clinical study (*e.g.*, basic research articles, review articles, case reports, *etc.*); (3) The patients suffered from pathological fractures and necrosis of the femoral head; (4) The control group did not refer to patients treated with CCS; and (5) The statistical methodologies used were inappropriate.

#### Data extraction and outcome measures

Data extraction from the included studies was independently undertaken by two authors. Data included the first author's name, publication year, patient sample size, patients' age, intervention group characteristics, control group characteristics, follow-up time, test type, outcome measurements, and fracture types. The outcome measurements included operation time, intraoperative blood loss, fracture healing time, hip function outcomes, and recorded complications. The failure of internal fixation of complications was defined by incidents involving screw loosening, back-offs, and penetration.

#### Assessment of bias risk and methodological quality of the included studies

The methodological quality of the included studies was independently assessed by two authors. The quality of each nonrandomized controlled study was assessed according to the methodological index for nonrandomized studies (MINORS) entry based on the MINORS scores: Studies with scores of > 12 were included[8]. The quality of each RCT was assessed by using the Cochrane Collaboration tool based on the following factors: random sequence generation, allocation concealment, participant and personnel blinding, outcome assessment blinding, incomplete outcome data, selective reporting, and other biases. Any dispute between the two authors was resolved *via* mutual discussion or with the assistance of the third author.

#### Statistical analysis

Both the meta-analysis and statistical analysis were performed using RevMan version 5.3 (Cochrane London, United Kingdom). Odds ratio (OR) and 95% confidence interval (CI) were used for dichotomous data analyses. Continuous data were presented as mean difference (MD) or standardized MD (SMD) and 95% CI. The Cochrane  $I^2$  test was used for assessing heterogeneity among the analyzed studies. Quartile data were converted into median and deviation with the use of an online resource (https://www.math.hkbu.edu.hk/); if the data skewed away from normality, they were subsequently excluded from the meta-analysis[9,10]. A random-effects model was applied if  $I^2$  was > 50%; otherwise, a fixed-effects model was applied. A *P* value of < 0.05 was considered to indicate statistical significance. This study was a systematic review and meta-analysis and did not require ethical approval. All data were obtained from published papers.

Zaishidena® WJCC | https://www.wjgnet.com

#### RESULTS

#### Study selection

A total of 94 studies were initially identified from the search of the aforementioned 5 electronic databases. After eliminating duplicates, the titles and abstracts of 71 relevant studies were screened. Of these, 61 studies were excluded for various reasons (e.g., studies referring to nonclinical trials, studies that were not RCTs or controlled trials, studies including a different diagnosis, studies using a different intervention, studies presenting duplicate data, and studies characterized by data defects). Based on their full text, 10 studies 11-20 conformed to the set inclusion criteria. The literature search procedure followed herein is illustrated in Figure 1.

#### Characteristics of the included studies

As shown in Table 1, the included studies were 10 retrospective controlled studies with a total of 711 participants. All of these studies compared use of the FNS with the use of CCS. Other detailed characteristics of these studies are presented in Table 1.

#### Risk of bias assessment

The RCTs' risk of bias assessment was evaluated using the Cochrane Collaboration tool. The results showed that there were no RCTs among the included studies. For the retrospective controlled studies, MINORS was used to assess the methodological quality. The interval scores of these were 17-19 points. Among these studies, two scored 17 points, six scored 18 points, and two scored 19 points in the MINORS assessment. Thus, the current meta-analysis is characterized by methodological quality limitations.

#### Operation time

In the meta-analysis presented in Figure 2A, 10 articles were included to analyze the operation time required for the surgical treatment of femoral neck fractures. The pooled results of included articles showed that compared with CCS, the FNS could not decrease the required operation time (SMD: -0.38, 95% CI: -0.98 to 0.22, P = 0.21,  $I^2 = 93\%$ ).

#### Blood loss

Seven studies reported blood loss, as presented in Figure 2B. The random-effects model was used due to the high level of heterogeneity observed (P < 0.001,  $l^2 = 81\%$ ). The pooled results of these trials revealed that compared with CCS, the FNS could increase intraoperative blood loss (SMD: 0.59, 95% CI: 0.15 to 1.03, P = 0.009,  $I^2 = 81\%$ ).

#### Fracture healing time

Among the studies included in this meta-analysis, seven studies, which included 510 participants, reported the fracture healing time (see Figure 2C). The random-effects model was used due to the high level of heterogeneity observed (P < 0.001,  $l^2 = 91\%$ ). The pooled results of these trials revealed that compared with CCS, the FNS could shorten the fracture healing time (SMD: -0.97, 95% CI: -1.65 to -0.30,  $P = 0.005, I^2 = 91\%$ ).

#### Harris Hip score at the last follow-up

Eight studies were included in the analysis of the Harris Hip score (HHS) at the last follow-up (Figure 2D). The random-effects model was used due to the high level of heterogeneity observed (P < P0.001,  $l^2 = 86\%$ ). The meta-analysis revealed that compared with CCS, the FNS could improve the HHS recorded at the last follow-up (SMD: 0.76, 95% CI: 0.31 to 1.21, *P* = 0.0009, *I*<sup>2</sup> = 84%).

#### Femoral neck shortening

Eight studies were included in the analysis of femoral neck shortening (Figure 2E). The fixed-effects model was used due to the low level of heterogeneity observed (P = 0.89,  $I^2 = 0\%$ ). The incidence of femoral neck shortening was lower after surgical treatment with the FNS than after surgical treatment with CCS (OR: 0.29, 95% CI: 0.14 to 0.61, *P* = 0.001, *I*<sup>2</sup> = 0%).

#### Failure of internal fixation

Seven studies were included in the analysis of failure of internal fixation (Figure 2F). The fixed-effects model was used due to the low level of heterogeneity observed (P = 0.95,  $I^2 = 0\%$ ). The included studies revealed that compared with CCS, the FNS could not reduce the incidence of the failure of internal fixation (OR: 0.49, 95%CI: 0.23 to 1.06, P = 0.07,  $I^2 = 0$ %).

#### Delayed union or nonunion

Seven studies were included in the meta-analysis of the occurrence of delayed union or nonunion (Figure 2G). The fixed-effects model was used due to the high level of heterogeneity observed (P = 0.71,



Table 1 Characteristics of the studies analyzed in the current meta-analysis										
Complications	A; B; C; D; E	A; B; C; F; G	A; B; D; E	A; B; E	B; I					
Outcomes	Operation time; intraop- erative blood loss; fracture healing time; HHS at the last follow- up	Operation time; intraop- erative blood loss; fracture healing time; HHS at the last follow- up	Operation time; intraop- erative blood loss; fracture healing time; HHS at the last follow- up	Operation time; intraop- erative blood loss; fracture healing time; HHS at the last follow- up	Operation time; intraop- erative blood loss; fracture healing time; HHS at the last follow- up					
Type of fracture	Garden II/III/IV	Pauwels I/II/III	Garden II/III/IV	Garden II/III/IV	Garden I/II/III/IV					
Study type	Retrospective study									
Follow-up time	≥6 mo	5-18 mo	≥ 12 mo	3-18 mo	Unknown					
G2	CCS	CCS	CCS	CCS	CCS					
G1	FNS	FNS	FNS	FNS	FNS					
Participants G2 ( <i>n</i> , age: mean ± SD)	38, 48.8 ± 10.1	47, 43.7 ± 13.1	57, 53.2 ± 11.3	58, 49	19, 41.2					
( <i>n</i> , age: G1 mean ± SD)	32, 49.4 ± 11.0	47, 47.8 ± 9.8	62, 54.0 ± 13.0	24, 52	15, 42.0					
First author, year	Ren C (2021) [11]	Yang J (2021) [12]	Xiong W (2021) [13]	Yan C (2021) [ <mark>14</mark> ]	Yang Y (2021) [15]					
Complications	A; B; E; H	A; D; E	B; E; H; I	A; B; E; D	В					
Outcomes	Operation time; intraop- erative blood loss; fracture healing time; HHS at the last follow- up	Operation time; intraop- erative blood loss; HHS at the last follow-up	Operation time; fracture healing time; HHS at the last follow-up	Operation time; intraop- erative blood loss; fracture healing time; HHS at the last follow- up	Operation time					
Type of fracture	Pauwels I/II/III	Pauwels III	Garden I/II/III/IV	Pauwels I/II/III	Garden I/II					
Study type	Retrospective study									
Follow-up time	≥6 mo	10-22 mo	12-24 mo	14-24 mo	3-6 mo					
G2	CCS	CCS	CCS	CCS	CCS					
G1	FNS	FNS	FNS	FNS	FNS					
Participants G2 ( <i>n</i> , age: mean ± SD)	24, 50.46 ± 9.26	30, 53.14 ± 7.19	36, 47.58 ± 10.31	45, 54.8 ± 11.7	32, 85 ± 6.6					
( <i>n</i> , age: G1 mean ± SD)	20, 50.45 ± 8.45	30, 54.53 ± 6.71	33, 50.61 ± 10.30	47, 57.4 ± 15.0	15, 86.1 ± 4.6					
First author (year)	Hu H (2021) [16]	Zhou X (2021) [17]	He C (2021) [18]	Tang Y (2021) [19]	Vazquez O (2021) [20]					

G1: Treatment group; G2: Control group; HHS: Harris Hip score; A: Avascular necrosis of the femoral head; B: Femoral neck shortening; C: Deep venous thrombosis; D: Loosening of screws; E: Delayed union or nonunion; F: Thigh irritation; G: Postoperative infection; H: Screw penetration; I: Screw back-off.

 $l^2 = 0\%$ ). Compared with CCS, the FNS reduced the incidence of delayed union or nonunion (OR: 0.47, 95% CI: 0.30 to 0.73, P = 0.001;  $l^2 = 0\%$ ).

#### Avascular necrosis of the femoral head

The development of avascular necrosis of the femoral head was reported in 7 studies, including 6 and 16 cases in the FNS and CCS groups, respectively (Figure 2H). No heterogeneity was observed ( $P = 1.00, P^2 = 0\%$ ) and, as such, the fixed-effects model was used. The obtained results revealed that there was no statistically significant difference in terms of the incidence of avascular necrosis of the femoral head between the two studied groups (OR: 0.46, 95% CI: 0.20 to 1.10, P = 0.08,  $P^2 = 0\%$ ).

#### Other complications

Other complications were also analyzed in this meta-analysis, and the obtained results are summarized in Table 2.

Baisbidena® WJCC | https://www.wjgnet.com

Table 2 Other complications reported in the analyzed studies										
Complications	Number of cases (FNS/other implants)	OR (95%CI)	Ρ	₽ (%)						
Deep venous thrombosis	3/5	0.64 (0.15, 2.78)	0.55	0						
Thigh irritation	0/15	0.02 (0.00, 0.38)	/	/						

FNS: Femoral Neck System; OR: Odds ratio; CI: Confidence interval.

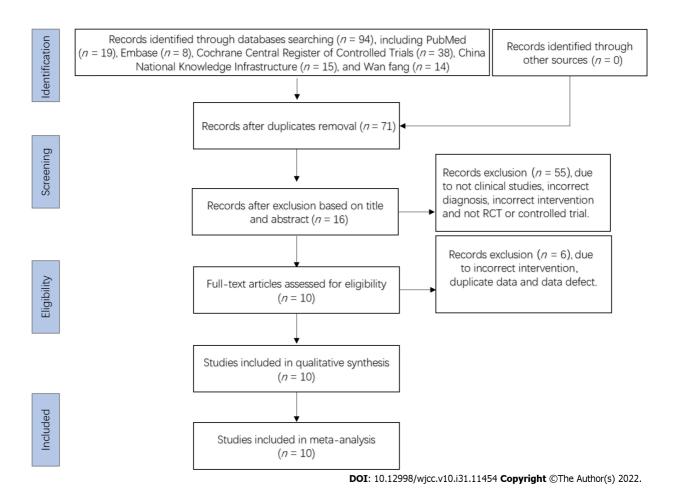


Figure 1 Flow diagram of the study selection process followed based on entries retrieved from five databases.

#### DISCUSSION

With the increase in the aging population, femoral neck fractures are becoming increasingly common every year; they are typically treated *via* internal fixation surgery, which tends to have several complications, such as fracture nonunion, femoral neck avascular necrosis, femoral neck shortening, and hip deformity[21,22]. To date, no harmonized standards exist regarding the choice of the right internal fixation technique. The FNS, which has superior biomechanical characteristics, was introduced in China in 2018, but there is insufficient evidence of its efficacy in the treatment of femoral fractures compared with traditional internal fixation techniques, such as CCS[23]. Thus, this study aimed to assess the efficacy of the FNS in comparison with that of CCS in the treatment of femoral fractures through systematic review and meta-analysis.

We searched 5 databases and identified 10 retrospective controlled studies (with a total of 711 participants) that met the inclusion criteria. In this meta-analysis, we found that there was no significant difference in the operation time between the FNS and CCS. Although the FNS has been introduced recently, it features simple operation (short learning curve) and low-level trauma[18]. CCS requires better spatial distribution of three screws, which may warrant the repeated adjustment of guidewires and increase the number of intraoperative fluoroscopies[18]. These may be the reasons why both required similar operation times. However, the pooled results revealed that intraoperative blood loss was higher when using the FNS than when using CCS. It is possible that all patients treated with the

Α		FNS			ccs			Std. Mean Differe	nce Std. Mean Difi	ference
Study or Subgroup 1.1.1 FNS vs. CCS	Mean	SD	Total	Mean	SD	Total	Weigh	t IV, Random, 95	% CI IV, Random,	95% CI
He C 2021	49.94	14.46	i 33	56.11	12.48	36	10.19	6 -0.45 [-0.93,1	0.03]	
Hu H 2021		26.35				24		6 0.66 [0.05,	1.28]	•
Oscar Vazquez 2021 Ren C 2021	43.3 47.2				25.4 22.6	32 38				
Tang Y 2021	52.4		47		11.9	45				
Xiong W 2021	45.2				11.7	57		• •		
Yan C 2021 Yang 1 2021	58.92 47.7				37.6 3.8	58 47				
Yang J 2021 Yang Y 2021	39.4				12.1	47		• •		
Zhou X 2021	42.83		30	40.9	5.22	30	10.19	6 0.38 [-0.13,	D.89j	
Subtotal (95% CI)	0.08-04		325 200 df		0 0000	386		% -0.38 [-0.98, 0	0.22]	
Heterogeneity: Tau <sup>2</sup> = Test for overall effect: 2				-9(/~~	0.0000	1), 11=	9370			
T-4-1 (05% OD			205			200	400.0			
Total (95% CI) Heterogeneity: Tau <sup>2</sup> =	0.86: Cł	ni² = 128	<b>325</b> 5.36. df		0.0000		100.0%	% -0.38 [-0.98, 0		
Test for overall effect.				- 0		.,,			-2 -1 0 Favours (FNS) Fa	1 2 avours (CCS)
Test for subaroup diffe	erences:	Not ap	plicable	e					r drodro (r rroj - r	
В		FNS			ccs			Std. Mean Differe		
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weigh	nt IV, Random, 9	5% CI IV, Random	, 95% Cl
1.2.1 FNS vs.other im Hu H 2021		50.47	20	23.71	28.13	24	13.09	% 1.13 [0.49,	1 771	
Ren C 2021	98.8	43.8	32	96.6	41	38				_
Tang Y 2021	50.6	10.6	47	47.3	11.9	45				
Xiong W 2021 Yan C 2021	50.8 79.17	9.9 50.17	62 24	48.9 74.83	10.2 42.73	57 58			· ·	_
Yang Y 2021	52.4	10.4	15	34.8	42.75	19				
Zhou X 2021	99.73		30		9.04	30	13.49	% 1.81[1.21,	2.42]	<b>_</b>
Subtotal (95% CI) Heterogeneity: Tau <sup>2</sup> =	0.20-0	hiz – po	230	-6/0-	0.00041	271 		% 0.59 [0.15,	1.03]	-
Test for overall effect:				- u (/~ <	0.0001	, in= 8	1 70			
							40-0		1.001	
Total (95% CI) Heterogeneity: Tau <sup>2</sup> =	0.281.01	hi≅– ⊃≏	230 21 df	= 6 (P~	0.0004		100.0	% 0.59 [0.15,		
Test for overall effect:				- 0 (/~ <	0.0001	/, i = 8	0.10		-2 -1 0	1 2
Test for subaroup diff				le					Favours (FNS) F	avours [CCS]
С		FNS		С	cs			Std. Mean Differen	ce Std. Mean Diffe	erence
Study or Subgroup	Mean		Total			otal	Weight	IV, Random, 95%		
1.4.1 FNS vs.other im He C 2021	plants 13.82	1.60	20	14.03	1 79	36	14.6%	-0.12 [-0.60, 0.	351 -	
He C 2021 Hu H 2021	3.53	0.9	20		1.01		13.9%	-0.62 [-1.23, -0.		
Ren C 2021	3.1	0.9	32	3.6	0.9		14.6%	-0.55 [-1.03, -0.		
Tang Y 2021	2.97	0.35	47		0.39		14.1%	-2.76 [-3.34, -2.		
Xiong W 2021 Yan C 2021	3.2 714	0.4 1.46	62 24	4 12.74	0.6 5.55		14.8% 14.4%	-1.57 [-1.98, -1. -1.17 [-1.68, -0.		
Yang Y 2021	16.4	2.8	15	16.3	3.3		13.6%	0.03 [-0.65, 0.		
Subtotal (95% CI)			233				100.0%	-0.97 [-1.65, -0.	30] 🔶	
Heterogeneity: Tau <sup>2</sup> = Test for overall effect:				= 6 ( <i>P</i> <	0.0000	1); l²=	91%			
	2 - 2.02								-	
Total (95% CI)			233				100.0%	-0.97 [-1.65, -0.	30] 🔷	
Heterogeneity: Tau <sup>2</sup> = Test for overall effect:				= b ( <i>P</i> <	0.0000	1); 1*=	91%		-2 -1 0	1 2
Test for subaroup diff				le					Favours (FNS) Fa	vours [CCS]
D		FNS		c	cs			Std. Mean Differen	ce Std. Mean Diff	erence
Study or Subgroup	Mean		Total			otal	Weight			
1.5.1 FNS vs. other in	-	4.00		00.4.	5.04	20	10.00	0.001.011.0		_
He C 2021 Hu H 2021	90.42 85.9	4.82 5.98		88.44 81.92		36 24	12.8% 11.8%	0.36 [-0.11, 0 0.53 [-0.07, 1		<u> </u>
Ren C 2021	96.8	J.90 4	32	93.6	6.7 6.7	38	12.8%	0.56 [0.08, 1		-
Tang Y 2021	88.9	4.3	47	84.4	3.2	45	13.1%	1.17 [0.73, 1	62]	
Xiong W 2021 Yon C 2021	91.8	4.4	62 24	84.6 95	3.3		13.2%	1.83 [1.40, 2		
Yan C 2021 Yang Y 2021	94.7 89.8	1.6 2.5	24 15	85 90.8	9 3.3		12.5% 11.2%	1.26 [0.74, 1 -0.33 [-1.01, 0		-
Zhou X 2021	86.16		30	82.37		30	12.5%	0.51 [-0.01, 1	02]	-
Subtotal (95% CI)	0.0510	hi <b>z</b> - **	263	-7/0	0.0000		100.0%	0.76 [0.31, 1.	21]	•
Heterogeneity: Tau <sup>2</sup> = Test for overall effect:				- 1 (P<	0.0000	n); i*=	04%			
							100 1			•
Total (95% CI) Heterogeneity: Tau <sup>2</sup> =	0.2610	hiž – 41	263 206 df	-7/0-	0.0000		100.0%	0.76 [0.31, 1.	21]	
Test for overall effect:					0.0000	o), r=	0470		-2 -1 0	1 2
Test for subaroup diff									Favours (FNS) Fa	vours [CCS]
E		FNS		CC	s			Odds Ratio	Odds Ratio	)
Study or Subgroup			otal	Events	Total	We	ight M	-H, Fixed, 95% Cl	M-H, Fixed, 95	% CI
1.6.1 FNS vs. other	implar				~-		~~~	0.05 10.00 0.00		
He C 2021		1	33	4	36		.6% .xa	0.25 [0.03, 2.36]		
Hu H 2021 Ren C 2021		0 0	20 32	6 4			.6% .8%	0.07 [0.00, 1.32] 0.12 [0.01, 2.28]		
Tang Y 2021		3	32 47	4 5			.0% .2%	0.55 [0.12, 2.43]		
Xiong W 2021		3	62	5			.8%	0.53 [0.12, 2.32]		
Yang J 2021		0	47	1	47		.0%	0.33 [0.01, 8.22]		_
Yang Y 2021		0	15	1	19			0.40 [0.02, 10.48]		_
Zhou X 2021 Subtotol (05% CD		0	30	3			.7%	0.13 [0.01, 2.61]		
Subtotal (95% CI)		7	286	20	296	100	.0%	0.29 [0.14, 0.61]	-	
Total events Heterogeneity: Chiª	= 2.93	7 . df = 7	(P=)	29 ۴  (89)						
Test for overall effe					- 0 /0					
Total (95% CI)		_	286	_	296	100	.0%	0.29 [0.14, 0.61]	•	
Total events		7		29						
Heterogeneity: Chi <sup>a</sup> Test for overall effe					= 0%				0.005 0.1 1	10 200
Test for subaroup o									Favours (FNS) Favo	ours [CCS]
		4								

-							
	FNS		ccs			Odds Ratio	Odds Ratio
Study or Subgroup		lotal	Events	lotal	weight	M-H, Fixed, 95% Cl	M-H, Fixed, 95% Cl
1.7.1 FNS vs. other in	-			~~			
He C 2021	0	33	2	36	12.0%	0.21 [0.01, 4.45]	
Hu H 2021	2	20	3	24	12.5%	0.78 [0.12, 5.18]	
Ren C 2021	0	32	1	38	6.9%	0.38 [0.02, 9.77]	
Tang Y 2021	2	47	4	45	19.9%	0.46 [0.08, 2.62]	
Xiong W 2021	4	62	6	57	29.7%	0.59 [0.16, 2.19]	
Yan C 2021	0	24	1	58	4.4%	0.78 [0.03, 19.88]	
Zhou X 2021	1	30	3	30	14.7%	0.31 [0.03, 3.17]	
Subtotal (95% CI)		248		288	100.0%	0.49 [0.23, 1.06]	-
Total events	9		20				
Heterogeneity: Chi <sup>2</sup> =	0.86, df=	6 (P =	0.99); l² :	= 0%			
Test for overall effect:	Z = 1.81 (	P = 0.0	)7)				
Total (95% CI)		248		288	<b>100.0</b> %	0.49 [0.23, 1.06]	-
Total events	9		20				
Heterogeneity: Chi <sup>2</sup> =	0.86, df=	6 (P=	0.99); l <sup>a</sup> :	= 0%			
Test for overall effect:	Z = 1.81 (	P = 0.0	)7)				
Test for subaroup diff	erences: l	Not app	olicable				Favours [FNS] Favours [CCS]
-						Odda D-41-	Odda D-41-
G	FNS	Teta!	CCS		Mainte	Odds Ratio	Odds Ratio
Study or Subgroup		10(3)	events	rotal	vveignt	M-H, Fixed, 95% Cl	M-H, Fixed, 95% Cl
1.8.1 FNS vs. other in	-		~		1.00	0.04 10.00.0.403	
He C 2021	1	33	3	36	4.9%	0.34 [0.03, 3.48]	
Hu H 2021	2	20	9	24	13.1%	0.19 [0.03, 0.99]	
Ren C 2021	3	32	4	38	5.9%	0.88 [0.18, 4.26]	
Tang Y 2021	13	47	20	45	26.2%	0.48 [0.20, 1.14]	
Xiong W 2021	21	62	25	57	30.6%	0.66 [0.31, 1.38]	
Yan C 2021	2	24	13	58	12.4%	0.31 [0.07, 1.52]	
Yang Y 2021	0	15	4	19	6.9%	0.11 [0.01, 2.24]	
Subtotal (95% CI)		233		277	100.0%	0.47 [0.30, 0.73]	<b>•</b>
Total events	42		78				
Heterogeneity: Chi² =				= 0%			
Test for overall effect:	Z = 3.29 (	P = 0.0	01)				
Total (95% CI)		233		277	100.0%	0.47 [0.30, 0.73]	•
Total events	42		78				
Heterogeneity: Chi² =				= 0%			0.005 0.1 1 10 200
Test for overall effect:	Z = 3.29 (	P = 0.0	)01)				Favours [FNS] Favours [CCS]
Test for subaroup diff	erences: I	Not app	olicable				
н	FNS		CCS			Odds Ratio	Odds Ratio
Study or Subgroup					Weight		
1.9.1 FNS vs. other in		1 ottai	Liono	Total	Togin	In The Taxou Control	Millindal box of
Hu H 2021	1	20	3	24	16.0%	0.37 [0.04, 3.85]	
Ren C 2021	Ó	32	1	38	8.3%	0.38 [0.02, 9.77]	
Tang Y 2021	1	47	3	45	18.5%	0.30 [0.02, 3.04]	
Xiong W 2021	4	47 62	5	40	30.0%	0.72 [0.18, 2.81]	<b>_</b>
Yan C 2021	4 0	24	2	58	9.0%	0.46 [0.02, 9.97]	
Yang J 2021	0	47	1	47	9.0%	0.33 [0.01, 8.22]	•
Zhou X 2021	0	30	1	47	9.1%	0.32 [0.01, 8.24]	
Subtotal (95% CI)	U	262	ſ	299	9.1%	0.32 [0.01, 8.24]	
Total events	6	202	16	233	100.0 //	0.40 [0.20, 1.10]	-
Heterogeneity: Chi <sup>2</sup> =	-	6/0-		- n%			
				- 070			
Test for overall effect:	∠=1.75 (	/~ = 0.U	19)				
Total (OE%, CI)		262		200	100.0%	0.4610.20.4.401	
Total (95% CI)	-	262		299	100.0%	0.46 [0.20, 1.10]	
Total events	6		16	~~			
Heterogeneity: Chi <sup>2</sup> =				= U%			0.01 0.1 1 10 100
Test for overall effect:							Favours [FNS] Favours [CCS]
Test for subaroup diff	erences: I						
			DOT: 10	1.1299	18/wicc	v10.i31.11454 <b>C</b>	opyright @The Author(s) 2022.



Figure 2 Meta-analysis focusing on the efficacy of the femoral neck system vs cannulated compression screws for the surgical treatment of femoral neck fractures. A: Length of the recorded operation time; B: Blood loss; C: Fracture healing time; D: Harris Hip score recorded at the last follow-up; E: Femoral neck shortening; F: Failure of internal fixation; G: Delayed union or nonunion; H: Avascular necrosis of the femoral head.

> FNS required open reduction, which could lead to surgical trauma with a small window of exposure. This may lead to similar operation times but more blood loss.

> Our data indicated that the chances of femoral neck shortening were lower when using the FNS than when using CCS. CCS are widely used for internal fixation in patients with femoral neck fractures owing to the minimally invasive surgical procedure, low cost, and antirotation force[18]. However, recent research has reported poor biomechanical properties of CCS for unstable femoral neck fractures [24]. A biomechanical study suggested that the FNS is a reliable implant for femoral neck fractures as it has biomechanical characteristics similar to those of dynamic hip screws (DHS) as well as stability superior to that of CCS[23]. In addition, a finite element analysis showed that the FNS exerts a higher internal fixation stress than CCS, which is about 1.6-3.0 times that of CCS[25]. Taken together, the FNS (which is characterized by the angular stability constructs of its bolt, antirotation screws, a lateral plate, and locking screws), provides superior resistance against femoral neck shortening, and its sliding design of antirotation and locking screws allow the surgeon to achieve the maximum sliding compression of 20 mm during the operation[19]. Interestingly, the incidence of internal fixation failure for the FNS was the same as that for CCS. In this meta-analysis, fixation failure included screw loosening, back-off, penetration, etc. It is possible that the incidence of fixation failure associated with the FNS is actually

lower due to fracture type, bone quality and reduction, and implant position. However, we may have observed similar incidences for the FNS and CCS due to factors such as small sample size and short follow-up time.

Previous studies showed that the nonunion rate of femoral neck fracture treated with CCS was higher than that of femoral neck fracture treated with angle-stabilized internal fixators [26,27]. Our study identified that compared with CCS, use of the FNS for treating femoral neck fractures could shorten the required fracture healing time as well as decrease the incidence of delayed union or nonunion. Time to surgery, fracture type, and bone reduction and quality may be the major determinants of bone healing. In addition, current evidence has shown that the stability of the femoral neck fracture is also crucial for promoting bone healing[28,29]. In general, the mechanical stability of a fractured bone osteosynthesis is composed of the stability of the internal implant and the stability of the bone. The FNS meets the demand of stability of the implant in the osteosynthesis of bone fracture and conserves less strength at the femoral head than that of intact bone after bone healing[30,31]. It is thought that the FNS accelerated the healing of the fracture and reduced the incidence of delayed union or nonunion owing to the stability of the osteosynthesis construct in the fracture gap. The pooled results showed that compared with CCS, use of the FNS for treating femoral neck fractures could improve the HHS at the last followup. Previous studies have reported that femoral neck shortening can decrease hip function, especially in severe cases[26,32,33]. The FNS decreases the incidence of femoral neck shortening, and patients treated with the FNS could perform the timely postoperative weight-bearing activities[18]. Although the HHS was higher in the FNS group, no difference between the FNS and CCS groups was observed for the incidence of femoral head avascular necrosis in this meta-analysis. Apart from factors such as fracture type, stability, and bone reduction and quality, it is reported that the large volume of the implant could damage the blood vessels of the femoral head[34]. As far as the design of the FNS is concerned, the diameters of the screw bolt and antirotation screws were 6.4 mm and 10 mm, respectively. Therefore, similar to CCS, the FNS could also preserve the peripheral vessels in the femoral head.

This meta-analysis has several limitations. First, all the included studies were classified as retrospective controlled studies with MINORS scores between 17 and 19; hence, there is a high risk of bias and methodological quality limitations in these studies. Second, the overall sample size of the analyzed studies was small. Third, the follow-up time in most of the included studies was short. Fourth, fracture type, reduction quality, implant position, patient age, and time from injury to surgery were important factors in gaining good results in this meta-analysis; however, these could not be analyzed as the included studies did not describe these data specifically. Finally, "control" referred to only CCS; as a result, this study does not provide a definite conclusion on whether the FNS is a superior internal fixation method for the surgical treatment of femoral neck fractures compared with other implants (apart from CCS).

The results of this meta-analysis could help in the selection of the most appropriate treatment for patients with femoral neck fractures. However, considering the high risk of biases and poor methodological quality of the studies included in this meta-analysis, further studies (preferably RCTs) are required to draw more reliable conclusions on the efficacy of the FNS in the treatment of femoral neck fractures in adult patients.

#### CONCLUSION

This meta-analysis showed that compared with CCS, the FNS cannot shorten the operation time but increases intraoperative blood loss. The pooled results also revealed that compared with CCS, the FNS can better promote fracture healing, improve the HHS at the last follow-up, and reduce the chances of developing femoral neck shortness and delayed union or nonunion in adult patients with femoral neck fracture. Nevertheless, further studies (preferably RCTs) are required to validate the findings of our study.

#### **ARTICLE HIGHLIGHTS**

#### Research background

Controversy remains around the available choices for the internal fixation of a femoral neck fracture. The femoral neck system (FNS) was developed in 2018 and has been widely applied since then as it can provide rigid fixation stability with less damage to the bone mass around the fracture.

#### Research motivation

No systematic reviews and meta-analyses have investigated the efficacy of the FNS in comparison with that of traditional internal fixation in the treatment of femoral fractures.

#### Research objectives

The purpose of our study was to assess the efficacy of the FNS in comparison with that of cannulated compression screws (CCS) in the treatment of femoral fractures through systematic review and metaanalysis.

#### Research methods

Five electronic databases (PubMed, Embase, Cochrane Central Register of Controlled Trials, China National Knowledge Infrastructure, and Wanfang) were searched from the earliest publication date to December 31, 2021. Reference Citation Analysis (https://www.referencecitationanalysis.com/) was used to check the results and further analyze the related articles. Controlled trials were included if the FNS was applied to the femoral neck fracture in adults and if it was compared with CCS for the achievement of internal fixation. The measurement outcomes included the required operation time, observed patient blood loss, extent of fracture healing, patient's Harris Hip score (HHS) at the last follow-up, and records of any complications (such as failure of internal fixation, femoral neck shortness, avascular necrosis of the femoral head, and delayed union or nonunion).

#### Research results

Ten retrospective controlled studies (involving 711 participants) were included in this meta-analysis. The meta-analysis showed that compared with CCS, use of the FNS could not decrease the operation time [standardized mean difference (SMD): -0.38, 95% confidence interval (CI): -0.98 to 0.22, P = 0.21,  $I^2 =$ 93%], but it could increase the intraoperative blood loss (SMD: 0.59, 95%CI: 0.15 to 1.03, P = 0.009,  $I^2 =$ 81%). The pooled results also showed that compared with CCS, the FNS could better promote fracture healing (SMD: -0.97, 95% CI: -1.65 to -0.30, P = 0.005, I<sup>2</sup> = 91%), improve the HHS at the last follow-up (SMD: 0.76, 95% CI: 0.31 to 1.21, P = 0.0009,  $I^2 = 84\%$ ), and reduce the chances of developing femoral neck shortness (OR: 0.29, 95% CI: 0.14 to 0.61, P = 0.001, l<sup>2</sup> = 0%) and delayed union or nonunion (OR: 0.47, 95% CI: 0.30 to 0.73, P = 0.001;  $I^2 = 0\%$ ) in adult patients with femoral neck fractures. However, there was no statistically significant difference between the FNS and CCS in terms of failure of internal fixation (OR: 0.49, 95% CI: 0.23 to 1.06, P = 0.07,  $l^2 = 0\%$ ) and avascular necrosis of the femoral head (OR: 0.46, 95% CI: 0.20 to 1.10, P = 0.08,  $I^2 = 0$ %).

#### Research conclusions

Contemporary evidence indicates that compared with CCS, the FNS could decrease the chances of developing femoral neck shortness and delayed union or nonunion in adults with femoral neck fractures. Simultaneously, it could accelerate fracture healing and improve the HHS in these patients.

#### Research perspectives

The FNS is an internal fixation method with superior characteristics in the treatment of femoral neck fractures. The results of this meta-analysis could help in the selection of the most appropriate treatment for patients with femoral neck fractures.

#### FOOTNOTES

Author contributions: Wu ZF and Luo ZH were responsible for the data management and formal analysis; Wu ZF and Hu LC were responsible for the manuscript design, concept and methodology; Luo ZH and Hu LC searched the literature; Wu ZF wrote the original draft; Luo YW was responsible for manuscript writing, reviewing and editing.

Supported by Guangdong Provincial Administration of Chinese Medicine Research Project, No. 20201168; and the Project of Foundations of the Guangdong Research Institute for Orthopedics and Traumatology of Chinese Medicine, No. GYH202101-02.

Conflict-of-interest statement: All authors report no relevant conflict of interest for this article.

PRISMA 2009 Checklist statement: The authors have read the PRISMA 2009 Checklist, and the manuscript was prepared and revised according to the PRISMA 2009 Checklist.

**Open-Access:** This article is an open-access article that was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution NonCommercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is noncommercial. See: https://creativecommons.org/Licenses/by-nc/4.0/

#### Country/Territory of origin: China

**ORCID number:** Zhi-Fang Wu 0000-0002-7170-2646; Zi-Heng Luo 0000-0001-7649-0024; Liu-Chao Hu 0000-0002-9881-



092X: Yi-Wen Luo 0000-0002-3832-7565.

S-Editor: Wu YXJ L-Editor: Webster JR P-Editor: Zhao S

#### REFERENCES

- Number of All-Listed Diagnoses for Discharges from Short-Stay Hospitals, by ICD-9-CM Code: United States National 1 Hospital Discharge Summary: CDC/NCHS National Hospital Discharge Survey; 2010 [DOI: 10.1037/e605082007-001]
- Cummings SR, Rubin SM, Black D. The future of hip fractures in the United States. Numbers, costs, and potential effects 2 of postmenopausal estrogen. Clin Orthop Relat Res 1990; 252: 163-166 [PMID: 2302881 DOI: 10.1097/00003086-199003000-00024
- Parker MJ. The management of intracapsular fractures of the proximal femur. J Bone Joint Surg Br 2000; 82: 937-941 [PMID: 11041577 DOI: 10.1302/0301-620x.82b7.11595]
- Bretherton CP, Parker MJ. Early surgery for patients with a fracture of the hip decreases 30-day mortality. Bone Joint J 2015; 97-B: 104-108 [PMID: 25568422 DOI: 10.1302/0301-620X.97B1.35041]
- Roberts KC, Brox WT. AAOS Clinical Practice Guideline: Management of Hip Fractures in the Elderly. J Am Acad 5 Orthop Surg 2015; 23: 138-140 [PMID: 25624366 DOI: 10.5435/JAAOS-D-14-00433]
- Hoshino CM, O'Toole RV. Fixed angle devices versus multiple cancellous screws: what does the evidence tell us? Injury 2015; 46: 474-477 [PMID: 25655212 DOI: 10.1016/j.injury.2014.12.008]
- Li J, Zhao Z, Yin P, Zhang L, Tang P. Comparison of three different internal fixation implants in treatment of femoral neck 7 fracture-a finite element analysis. J Orthop Surg Res 2019; 14: 76 [PMID: 30871584 DOI: 10.1186/s13018-019-1097-x]
- 8 Slim K, Nini E, Forestier D, Kwiatkowski F, Panis Y, Chipponi J. Methodological index for non-randomized studies (minors): development and validation of a new instrument. ANZ J Surg 2003; 73: 712-716 [PMID: 12956787 DOI: 10.1046/j.1445-2197.2003.02748.x
- Shi J, Luo D, Weng H, Zeng XT, Lin L, Chu H, Tong T. Optimally estimating the sample standard deviation from the fivenumber summary. Res Synth Methods 2020; 11: 641-654 [PMID: 32562361 DOI: 10.1002/jrsm.1429]
- 10 Luo D, Wan X, Liu J, Tong T. Optimally estimating the sample mean from the sample size, median, mid-range, and/or mid-quartile range. Stat Methods Med Res 2018; 27: 1785-1805 [PMID: 27683581 DOI: 10.1177/0962280216669183]
- Ren C, Ma T, Li M, Xu Y, Li Z, Sun L. Short-term effectiveness of femoral neck system in treatment of femoral neck 11 fracture in young and middle-aged patients. Chin J Orthop Trauma 2021; 23: 769-774
- 12 Yang J, Zhou X, Zhu W, Li L, Xu W, Xia R. Comparison of short-term effectiveness of femoral neck system and cannulate compression screw in treatment of femoral neck fracture in young and middle-aged patients. Zhonghua Chuangshang Guke Zazhi 2021; 23: 761-768
- 13 Xiong W, Yi M, Long C, Liu L, Cen S, Huang F. Comparison of effectiveness of femoral neck system and inverted triangle cannulate screws in treatment of femoral neck fracture in adults. Zhonghua Chuangshang Guke Zazhi 2021; 23: 748-753
- 14 Yan C, Wang X, Xiang C, Jiang K, Li Y, Chen Q, Deng C, Chen L. [Comparison of effectiveness of femoral neck system and cannulate compression screw in treatment of femoral neck fracture in young and middle-aged patients]. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi 2021; 35: 1286-1292 [PMID: 34651482 DOI: 10.7507/1002-1892.202103099]
- Yang Y, Ma T, Zhang X, Luo X, Fan T, Wang Y. [Short-term effectiveness of femoral neck system in the treatment of femoral neck fracture]. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi 2021; 35: 539-543 [PMID: 33998204 DOI: 10.7507/1002-1892.202012097
- 16 Hu H, Cheng J, Feng M, Gao Z, Wu J, Lu S. Clinical outcome of femoral neck system versus cannulated compression screws for fixation of femoral neck fracture in younger patients. J Orthop Surg Res 2021; 16: 370 [PMID: 34107990 DOI: 10.1186/s13018-021-02517-z
- 17 Zhou XQ, Li ZQ, Xu RJ, She YS, Zhang XX, Chen GX, Yu X. Comparison of Early Clinical Results for Femoral Neck System and Cannulated Screws in the Treatment of Unstable Femoral Neck Fractures. Orthop Surg 2021; 13: 1802-1809 [PMID: 34351048 DOI: 10.1111/os.13098]
- He C, Lu Y, Wang Q, Ren C, Li M, Yang M, Xu Y, Li Z, Zhang K, Ma T. Comparison of the clinical efficacy of a femoral 18 neck system versus cannulated screws in the treatment of femoral neck fracture in young adults. BMC Musculoskelet Disord 2021; 22: 994 [PMID: 34844578 DOI: 10.1186/s12891-021-04888-0]
- 19 Tang Y, Zhang Z, Wang L, Xiong W, Fang Q, Wang G. Femoral neck system versus inverted cannulated cancellous screw for the treatment of femoral neck fractures in adults: a preliminary comparative study. J Orthop Surg Res 2021; 16: 504 [PMID: 34399801 DOI: 10.1186/s13018-021-02659-0]
- 20 Vazquez O, Gamulin A, Hannouche D, Belaieff W. Osteosynthesis of non-displaced femoral neck fractures in the elderly population using the femoral neck system (FNS): short-term clinical and radiological outcomes. J Orthop Surg Res 2021; 16: 477 [PMID: 34348753 DOI: 10.1186/s13018-021-02622-z]
- Duffin M, Pilson HT. Technologies for Young Femoral Neck Fracture Fixation. J Orthop Trauma 2019; 33 Suppl 1: S20-21 S26 [PMID: 30540668 DOI: 10.1097/BOT.00000000001367]
- 22 Slobogean GP, Stockton DJ, Zeng BF, Wang D, Ma B, Pollak AN. Femoral neck shortening in adult patients under the age of 55 years is associated with worse functional outcomes: Analysis of the prospective multi-center study of hip fracture outcomes in China (SHOC). Injury 2017; 48: 1837-1842 [PMID: 28651782 DOI: 10.1016/j.injury.2017.06.013]
- 23 Schopper C, Zderic I, Menze J, Müller D, Rocci M, Knobe M, Shoda E, Richards G, Gueorguiev B, Stoffel K. Higher stability and more predictive fixation with the Femoral Neck System versus Hansson Pins in femoral neck fractures Pauwels II. J Orthop Translat 2020; 24: 88-95 [PMID: 32775200 DOI: 10.1016/j.jot.2020.06.002]



- 24 Ye Y, Chen K, Tian K, Li W, Mauffrey C, Hak DJ. Medial buttress plate augmentation of cannulated screw fixation in vertically unstable femoral neck fractures: Surgical technique and preliminary results. Injury 2017; 48: 2189-2193 [PMID: 28818323 DOI: 10.1016/j.injury.2017.08.017]
- 25 Fan Z, Huang Y, Su H, Jiang T. How to choose the suitable FNS specification in young patients with femoral neck fracture: A finite element analysis. Injury 2021; 52: 2116-2125 [PMID: 34154816 DOI: 10.1016/j.injury.2021.05.043]
- 26 Weil YA, Qawasmi F, Liebergall M, Mosheiff R, Khoury A. Use of fully threaded cannulated screws decreases femoral neck shortening after fixation of femoral neck fractures. Arch Orthop Trauma Surg 2018; 138: 661-667 [PMID: 29427201 DOI: 10.1007/s00402-018-2896-y]
- Samsami S, Saberi S, Sadighi S, Rouhi G. Comparison of Three Fixation Methods for Femoral Neck Fracture in Young 27 Adults: Experimental and Numerical Investigations. J Med Biol Eng 2015; 35: 566-579 [PMID: 26500470 DOI: 10.1007/s40846-015-0085-9]
- 28 Sevitt S. Avascular necrosis and revascularisation of the femoral head after intracapsular fractures; a combined arteriographic and histological necropsy study. J Bone Joint Surg Br 1964; 46: 270-296 [PMID: 14167637]
- Dargan DP, Callachand F, Diamond OJ, Connolly CK. Three-year outcomes of intracapsular femoral neck fractures fixed 29 with sliding hip screws in adults aged under sixty-five years. Injury 2016; 47: 2495-2500 [PMID: 27637999 DOI: 10.1016/j.injury.2016.09.013]
- Augat P, Bliven E, Hackl S. Biomechanics of Femoral Neck Fractures and Implications for Fixation. J Orthop Trauma 30 2019; 33 Suppl 1: S27-S32 [PMID: 30540669 DOI: 10.1097/BOT.00000000001365]
- Rupprecht M, Grossterlinden L, Ruecker AH, de Oliveira AN, Sellenschloh K, Nüchtern J, Püschel K, Morlock M, 31 Rueger JM, Lehmann W. A comparative biomechanical analysis of fixation devices for unstable femoral neck fractures: the Intertan versus cannulated screws or a dynamic hip screw. J Trauma 2011; 71: 625-634 [PMID: 21768904 DOI: 10.1097/TA.0b013e31820e86e6
- 32 Zielinski SM, Keijsers NL, Praet SF, Heetveld MJ, Bhandari M, Wilssens JP, Patka P, Van Lieshout EM; FAITH Trial Investigators. Femoral neck shortening after internal fixation of a femoral neck fracture. Orthopedics 2013; 36: e849-e858 [PMID: 23823040 DOI: 10.3928/01477447-20130624-13]
- 33 Haider T, Schnabel J, Hochpöchler J, Wozasek GE. Femoral shortening does not impair functional outcome after internal fixation of femoral neck fractures in non-geriatric patients. Arch Orthop Trauma Surg 2018; 138: 1511-1517 [PMID: 30054814 DOI: 10.1007/s00402-018-3011-0]
- van Walsum ADP, Vroemen J, Janzing HMJ, Winkelhorst T, Kalsbeek J, Roerdink WH. Low failure rate by means of 34 DLBP fixation of undisplaced femoral neck fractures. Eur J Trauma Emerg Surg 2017; 43: 475-480 [PMID: 27084541 DOI: 10.1007/s00068-016-0659-4]





### Published by Baishideng Publishing Group Inc 7041 Koll Center Parkway, Suite 160, Pleasanton, CA 94566, USA Telephone: +1-925-3991568 E-mail: bpgoffice@wjgnet.com Help Desk: https://www.f6publishing.com/helpdesk https://www.wjgnet.com

