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Review Article

Comparisons of internal fixation treatments for femoral intertrochanteric fractures: a network meta-analysis

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Abstract: *Objective:* To identify the optimal treatment of femoral intertrochanteric fracture through multiple comparisons of gamma nail (GN), sliding hip screw (SHS), proximal femoral nail (PFN), proximal femoral nail antirotation (PFNA), percutaneous compression plate (PCCP), and Targon proximal femoral (Targon PF). *Methods:* We searched the Embase and PubMed databases in accordance with inclusion and exclusion criteria. Quality assessment was performed using the recommendation of the Cochrane Collaboration. All outcomes were assessed using odds ratio, standardized mean difference, and 95% confidence interval. The random-effects model was used to examine all the outcomes. Node-splitting analysis and the Brooks-Gelman-Rubin method were applied for consistency test and convergence assessment, respectively. The Aggregate Data Drug Information System was used for the statistical analysis. *Results:* In total, 31 eligible studies were included. The multiple comparisons indicated that PFNA for blood loss and non-union, PCCP for operative time and mortality, SHS for embolism, intraoperative fracture and later fracture, and Targon PF for reoperation and wound infection were the optimal treatments. Rank probability showed that SHS was the best option for blood loss, embolism, intraoperative fracture, and later fracture; and Targon PF, for operative time, mortality, non-union, reoperation, and wound infection. The subgroup analysis revealed that blood loss, cut-out incidence, and wound infection were lowest and the operative time was shortest with the PFN. *Conclusion:* No optimal internal fixation treatment was identified for femoral intertrochanteric fracture, but PFN may be a better treatment option for unstable femoral intertrochanteric fractures.

Keywords: Femoral intertrochanteric fracture, sliding hip screw, Targon proximal femoral, network meta-analysis

Introduction

Femoral intertrochanteric or intertrochanteric hip fractures, which are common in elderly patients, are a extracapsular fractures that occur between the femur neck fundus and smaller trochanter [1]. Elderly patients with osteoporosis often have unstable intertrochanteric fractures induced by minor external forces, and the following long-time clinotherapy can result in complications such as deep vein thrombosis, hypostatic pneumonia, and bedsore [2]. The incidence and mortality of the complications (including coax vara) induced by conservative treatment are as high as 50% and 35%, respectively [3].

At present, the fixation materials for femoral intertrochanteric fractures include the extramedullary (e.g., dynamic hip screw, DHS) and intramedullary fixation systems (e.g., gamma nail [GN], sliding hip screw [SHS], proximal femoral nail [PFN], proximal femoral nail antirotation [PFNA], percutaneous compression plate [PCCP], and Targon proximal femoral [Targon PF]) [4]. PFNA provides additional anchoring in cancellous bone and can be used to treat unstable proximal femoral fractures [5]. PFN, characterized by minimal invasive, was developed for treating unstable pertrochanteric, intratrochanteric, and subtrochanteric femoral fractures [6]. PFNA is better than the third-generation GN in the treatment of trochanteric fractures when considering fluoroscopy time and blood loss, whereas GN is better when considering intraoperative and postoperative complications, and functional outcome [7]. SHS attached with a lateral trochanteric support

plate provides stability and can inhibit medial displacement of the femoral shaft in unstable intertrochanteric femur fractures [8]. PCCP can reduce complications and improve fracture healing and rehabilitation in patients with intertrochanteric hip fractures [9]. Kawatani *et al.* and Heinert *et al.* indicate that Targon PF is an effective and safe therapy for the treatment of trochanteric proximal femoral fractures [10, 11]. Yu *et al*. [12] performed pairwise comparison of different internal fixation treatments for intertrochanteric fracture. However, no research has reported a comprehensive comparison of different therapies, and conclusions about the optimal therapy for femoral intertrochanteric fracture are inconsistent.

In the present study, we conducted a network meta-analysis to identify the optimal treatment for femoral intertrochanteric fractures. The indicators included blood loss, cut-out incidence, operative time, embolism, hospital stay, intra-operative fracture, later fracture, mortality, non-union, re-operation and wound infection.

Materials and methods

Search strategy

We searched the electronic databases of Embase (http://www.embase.com) and PubMed (http://www.ncbi.nlm.nih.gov/pubmed), updated to March 2016. The search terms were ("intertrochanteric fracture" OR "femoral intertrochanteric fracture" OR "intertrochanteric femoral fracture") and (GN or "Gamma Nail" or SHS or "Sliding Hip Screw" or DHS or "Dynamic Hip Screw" or PFN or "Proximal Femoral Nail" or PFNA or "Proximal Femoral Nail Antirotation" or PCCP or "Percutaneous Compression Plate" or "Targon PF" or "Targon Proximal Femoral"). The literature language was restricted to English.

Study selection

The inclusion criteria were as follows: (1) the study was a randomized controlled trial (RCT) about different internal fixation treatments for femoral intertrochanteric fracture, and (2) the curative effect of various treatments on intertrochanteric fracture (e.g., mortality, blood loss, hospital stays, and fracture rate) was reported in the literature. By contrast, reviews, reports, comments, and letters were excluded.

Data extraction and quality assessment

Two reviewers extracted the following information from all eligible studies independently, including the name of first author, year of publication, study area, research time, intervention, the number of cases, demographic characteristics (e.g., sex and age), and the time of follow-up. The recommendation of the Cochrane Collaboration [13] was used to assess the methodological quality of RCT. During data extraction and quality assessment, the disagreements were settled by discussing and communicating with the third reviewer to reach a consensus.

Statistical analysis

As a decision support system, the Aggregate Data Drug Information System (ADDIS) can evaluate and process data using the Bayesian framework and Markov Chain Monte Carlo (MCMC) theory [14, 15]. All the data in this meta-analysis were analyzed using ADDIS, with the following parameters: inference samples, 10000; number of chains, 4; simulation iterations, 50,000; thinning interval, 10; tuning iterations, 20,000; and variance scaling factor, 2.5. The odds ratio (OR), standardized mean difference (SMD), and 95% confidence interval (CI) were used as effect indexes. The random-effects model was used for all test models. A node-splitting analysis was used for the consistency test, and the consistency model was used when the *P* value was >0.05; otherwise, the inconsistency model was used [16]. For the subgroup analysis, the inconsistency standard deviation was used in the consistency test for blood loss, embolism, and mortality, while the node-splitting analysis was used for cut-out incidence, operative time, hospital stay, non-union, reoperation, and wound infection. The convergence of the model was evaluated using the Brooks-Gelman-Rubin method [17]. A potential scale reduction factor (PSRF) value close to 1.00 indicates a good convergence of the model. Generally, a PSRF value of <1.20 was acceptable.

Results

Eligible studies

The flowchart of the study selection is shown in **Figure 1**. In total, 4990 studies were retrieved

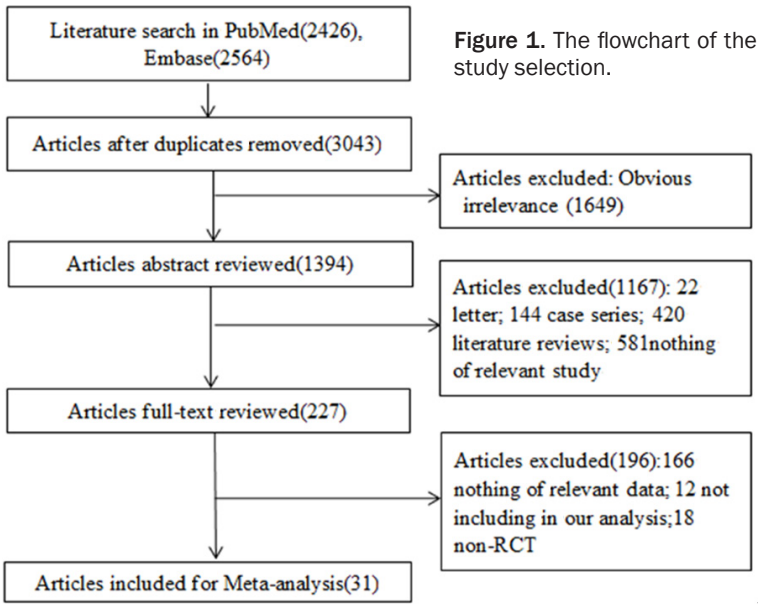

Figure 1. The flowchart of the study selection.

from the Embase and PubMed databases. After eliminating the duplicates and reviewing the titles and abstracts, 4763 studies were excluded. The remaining 227 studies were further selected by browsing full texts, and then 196 studies were excluded. Among the 196 excluded studies, 12 were screened out for their therapeutic methods (e.g., less invasive stabilization system, intramedullary hip screw, ACE nails, and Medoff sliding plate) not forming a closed loop with other therapies. Finally, 31 eligible studies were included in the meta-analysis [18-48]. The study areas of the included studies (from 1991 to 2014, mainly after 2004) were the United States, Canada, Australia, New Zealand, China, and so on. The follow-up time was between 6 and 12 months, and the intervention included GN, SHS, PFN, PFNA, PCCP, and Targon PF. No significant difference in demographic characteristics (e.g., sex and age) for each treatment group and the elderly (>65 years) accounted for a larger proportion (**Table 1**). As shown in **Figure 2**, the risks of random sequence generation (selection bias), allocation concealment (selection bias), and incomplete outcome data (attrition bias) in the quality of RCT studies were high.

Network meta-analysis

GN, SHS, PFN, PFNA, PCCP, and Targon PF were used as the target factors for the node-splitting analysis of blood loss, cut-out incidence, operative time, embolism, hospital stay, intraoperative fracture, later fracture, mortality, nonunion, reoperation, and wound infection. For blood loss, operative time, embolism, hospital stay, intraoperative fracture, later fracture, mortality, nonunion, reoperation, and wound infection, the results of the consistency test showed consistency; thus, the consistency model was used. For cut-out incidence, the inconsistency model was used because the results of the consistency test were not ideal. The PSRF values were 1.00, 1.00-1.18, 1.00, 1.00-1.03, 1.00-1.02, 1.00-1.13, 1.00-1.14, 1.00-1.01, 1.00-1.04, 1.00-1.01, and 1.00-1.03 for blood loss, cut-out incidence, operative time, embolism, hospital stay, intraoperative fracture, later fracture, mortality, nonunion, reoperation, and wound infection, respectively, all indicating a complete convergence and stable results (**Table 2**).

As shown in **Table 3**, PFNA was the optimal choice for internal fixation treatment of femoral intertrochanteric fractures both in terms of blood loss (OR, 95% CI: PFNA *vs*. GN, -128.68, -285.51 to -28.16; PFNA *vs*. PCCP: -20.18, -192.11 to -144.75; and PFNA *vs*. SHS: -183.12, -315.67 to -53.11) and nonunion (OR, 95% CI: PFNA *vs*. GN, 0.47, 0.06-2.80; PFNA *vs*. PFN, 0.81, 0.00-5.96; PFNA *vs*. SHS: 0.57, 0.07-3.70; and PFNA *vs*. Targon PF, 0.27, 0.01-4.43). PCCP was the optimal choice for internal fixation treatment of femoral intertrochanteric fractures both in terms of operative time (OR, 95% CI: PCCP *vs*. GN, -9.50, -26.87 to 7.15; PCCP *vs*. PFN, -5.95, -29.77 to 17.92; PCCP *vs*. PFNA, -2.28, -19.87 to 14.92; PCCP *vs*. SHS, -10.92, -25.67 to 3.13; and PCCP *vs*. Targon PF, -16.73, -43.86 to 10.40) and mortality (OR, 95% CI: PCCP *vs*. GN, 0.83, 0.40-1.73; PCCP *vs*. PFN, 0.67, 0.26-1.65; PCCP *vs*. PFNA, 0.75, 0.23-2.49; PCCP *vs*. SHS, 0.76, 0.41-1.47; and PCCP *vs*. Targon PF, 0.76, 0.26-2.18). Meanwhile, SHS was the optimal choice for internal fixation treatment of femoral intertrochanteric fracture in embolism (OR, 95% CI: SHS *vs*. GN, 0.88, 0.37-2.07; and SHS *vs*. PFN, 0.65, 0.16-2.28), intraoperative fracture (OR, 95% CI: SHS *vs*. GN, 0.16, 0.03-0.53; and SHS *vs*. PFN,

Table 1. Characteristics of the included studies

Author	Public year	Country	Study year	Follow-up (month)	Intervention		N		Gender (Male)		Age (Mean (SD))	
					E	C	E	C	E	C	E	C
Adams CI	2001	UK	1994-1995	12	GN	SHS	203	197	39	49	81.2±8.5	80.7±11.7
Ahrengart L	2001	Sweden	NA	6	GN	SHS	210	216	62	61	NA	NA
Aktselis I	2014	Greece	2008-2011	12	GN	SHS	40	40	12	12	82.9±5.8	83.1±6.5
Barton TM	2010	UK	NA	12	GN	SHS	100	110	19	25	83.1±9.5	83.3±6.8
Bridle SH	1991	UK	NA	6	GN	SHS	49	51	9	7	NA	NA
Garg B	2011	India	2007-2008	40	SHS	PFNA	39	42	27	323	64.3±4.5	60.2±5
Guo QS	2013	China	2008-2011	12	PFNA	PCCP	45	45	16	19	74.2±8.8	71.6±7.5
Herrera A	2002	Spain	1997-2000	12	GN	PFN	125	125	NA	NA	NA	NA
Hoffman CW	1996	Newzealand	NA	6	GN	SHS	31	36	4	12	83.2±8.1	79±10.4
Janzing HMJ	2001	Netherland	1998-1999	12	SHS	PCCP	44	39	10	4	83±8.5	82±7.7
Kosygan KP	2002	UK	NA	6	SHS	PCCP	56	55	12	9	82.8±9	82.7±8.5
Kukla C	1997	Austria	1993-1994	6	GN	SHS	60	60	14	4	83±9.1	84±8.3
Leung KS	1992	Hong Kong	NA	12	GN	SHS	113	113	25	30	80.8±8.4	78.3±9.5
O'Brien PJ	1995	Canada	1989-1991	12	GN	SHS	52	49	9	17	83±9.5	77±13.7
Ovesen O	2006	Darmark	2001-2003	12	GN	SHS	73	73	20	21	79.9±10	78.5±11.7
Papasimos S	2005	Greece	200-2002	12	GN	SHS	40	40	16	14	NA	NA
					GN	PFN	40	40	16	17	NA	NA
Park JH	2010	Korea	2005-2007	24	PFNA	PFN	23	17	6	3	75.7±6.7	67±11
Park SR	1998	Korea	1993-1995	18	GN	SHS	30	30	10	14	NA	NA
Parker MJ	2012	UK	2002-2009	12	SHS	Targon PF	300	300	52	69	82.4±13	81.4±12.8
Peyser A	2007	Israel	2002-2003	12	SHS	PCCP	53	50	18	16	82.5±8.0	78.9±8.2
Radford PJ	1993	UK	NA	12	GN	SHS	100	100	79	76	83±6.2	78±5
Saudan M	2002	Switzerland	1999-2000	12	SHS	PFN	106	100	22	24	83.7±10.1	83±9.7
Schipper IB	2004	Netherland	NA	12	GN	PFN	213	211	37	38	NA	NA
Utrilla AL	2004	Spain	1998-2000	12	GN	SHS	104	106	38	28	80.6±7.5	79.8±7.3
Vaquero J	2012	Spain	NA	12	GN	PFNA	31	33	5	3	83.5±7.4	83.6±7.5
VarelaEgocheaga JR	2009	Spain	2006-2007	12	GN	PCCP	40	40	6	11	NA	NA
Wild M	2010	Germany	2006-2007	12	PFNA	Targon PF	40	40	20	20	81.8±8.5	83.1±11.7
Xu YZ1	2010	China	2006-2008	17	GN	PFNA	70	66	27	27	75.4±1.0	76±1.2
Xu YZ2	2010	China	2006-2008	12	SHS	PFNA	55	51	16	15	77.9±7.8	78.5±8.0
Zou J	2009	China	2004-2007	12	SHS	PFNA	63	58	15	12	65±13.7	65±13.5
Yang E	2011	USA	2006-2007	NA	SHS	PCCP	33	33	7	11	77±14.2	76±17.5

N: Number of patients; GN: Gamma Nail; SHS: Sliding Hip Screw; PFN: Proximal Femoral Nail; PFNA: Proximal Femoral Nail Antirotation; PCCP: Percutaneous Compression Plate; Targon PF: Targon Proximal Femoral; E: Eexperimental group; C: Control group; NA: Not avilable; SD: Standard deviation.

0.86, 0.06-10.58), and later fracture (OR, 95% CI: SHS *vs.* GN, 0.03, 0.00-0.26; SHS *vs.* PFN, 0.05, 0.00-1.45; and SHS *vs.* PFNA, 0.05, 0.00-1.41). Moreover, Targon PF was the optimal choice for internal fixation treatment of femoral intertrochanteric fracture both reoperation (OR, 95% CI: Targon PF *vs.* GN, 0.15, 0.03-0.53; Targon PF *vs.* PFN, 0.10, 0.02-0.44; Targon PF *vs.* PFNA, 0.58, 0.17-2.41; and Targon PF *vs.* SHS, 0.24, 0.06-0.75) and wound infection (OR, 95% CI: Targon PF *vs.* GN, 1.02, 0.21-6.91; Targon PF *vs.* PFN, 1.04, 0.14-7.46; Targon PF *vs.* PFNA, 0.58, 0.09-2.88; and Targon PF *vs.* SHS, 0.85, 0.17-4.09). However, no significant differences were found in cut-out incidence and hospital stay among the different therapies. The network diagram for the multiple comparisons of GN, SHS, PFN, PFNA, PCCP, and Targon PF based on the different indicators is shown in **Figure 3**.

Rank probability

For estimation analysis, the MCMC method is a simulation-based approach; thus, the rank for treatments can be calculated on the basis of their performance in each simulation [49]. The treatment ranking for all therapies is shown in **Figure 4**. In consideration of blood loss (**Figure 4A**), embolism (**Figure 4B**), intraoperative fracture (**Figure 4C**), and later fracture (**Figure 4D**), SHS was the best among the therapies. Meanwhile, Targon PF was the best among the therapies when taking operative

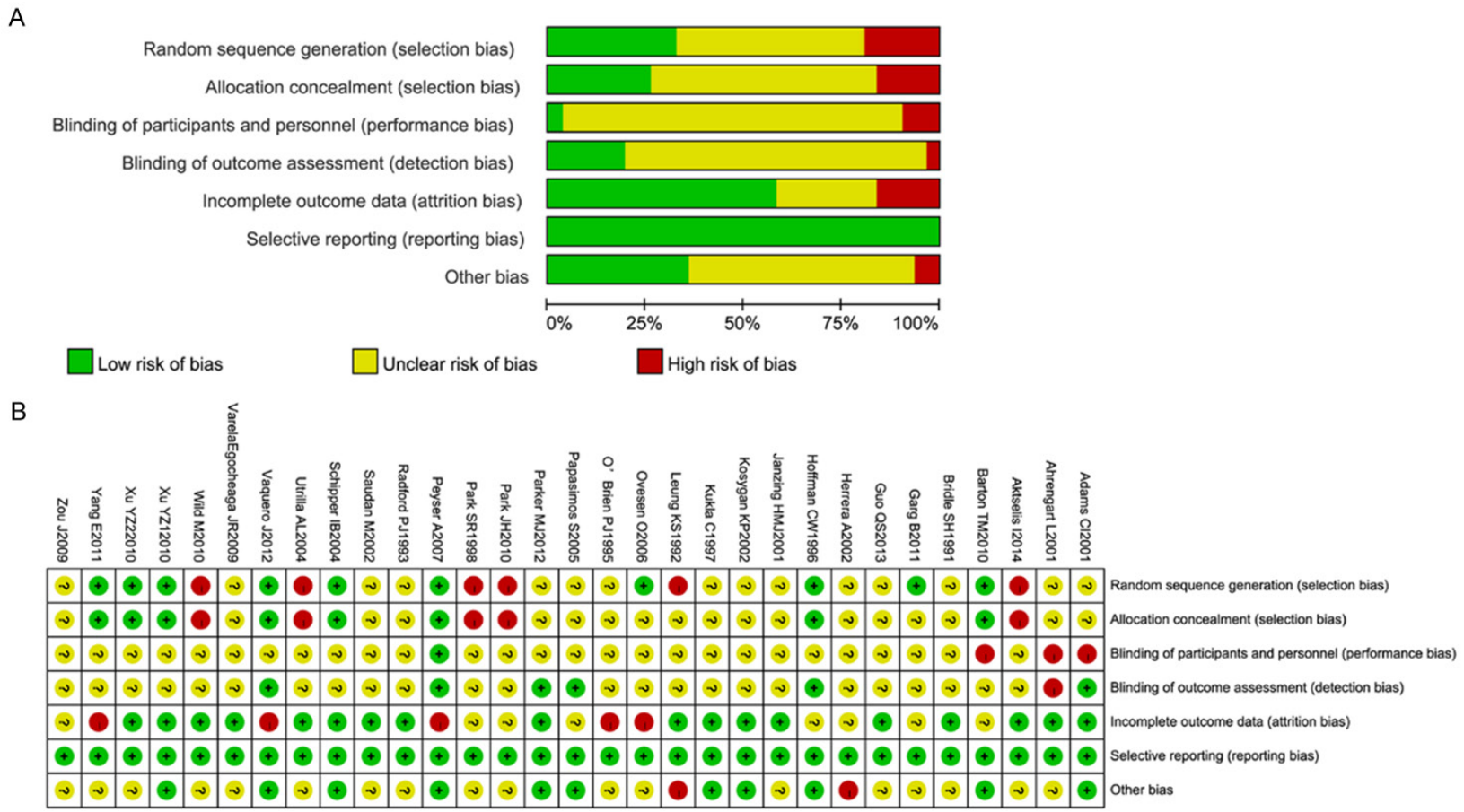

Figure 2. Quality assessments of the 31 included studies in the present meta-analysis. A: Bias risk of the eligible studies; B: Sensitivity and specificity of the identified studies. "+" represents low risk of bias, "?" indicates unclear risk of bias, and "-" stands for high risk of bias.

Table 2. Node-splitting analysis for the blood loss, cut out, operative time, embolism, hospital stay, intra-operative fracture, later fracture, mortality, non-union, re-operation and wound infection

	Name	Direct effect	Indirect effect	Overall	*P*-value
Blood loss	GN, PFNA	-54.57 (-314.75,199.04)	-182.56 (-381.76, 27.26)	-128.68 (-285.51, 28.16)	0.37
	GN, SHS	31.28 (-92.05, 171.27)	157.14 (-136.93, 448.40)	54.62 (-61.73, 173.05)	0.38
	PCCP, PFNA	37.41 (-224.06, 300.14)	-76.22 (-317.72, 166.01)	-20.18 (-192.11, 144.75)	0.47
	PCCP, SHS	131.58 (-49.85, 321.04)	245.70 (-51.57, 546.20)	162.87 (9.50, 315.27)	0.45
	PFNA, SHS	253.27 (112.22,393.02)	82.74 (-71.41, 256.75)	183.12 (53.11, 315.67)	0.11
Cut out	GN, PCCP	-29.15 (-81.03, -1.56)	-1.34 (-4.07, 1.00)	-1.71 (-4.46, 0.41)	0.05
	GN, PFN	-0.69 (-2.48, 0.72)	0.92 (-2.40, 4.93)	-0.41 (-1.84, 0.72)	0.34
	GN, PFNA	15.61 (1.18, 54.30)	-3.10 (-6.31, -0.94)	-1.00 (-2.95, 1.05)	0.00
	GN, SHS	-0.63 (-1.56, 0.33)	0.13 (-2.37, 2.67)	-0.49 (-1.27, 0.32)	0.52
	PCCP, SHS	0.85 (-1.46, 3.48)	44.48 (4.27, 101.47)	1.21 (-0.81, 3.83)	0.02
	PFN, SHS	-0.17 (-2.59, 1.99)	0.10 (-1.64, 2.23)	-0.06 (-1.35, 1.46)	0.81
	PFNA, SHS	10.42 (1.91, 23.99)	-1.66 (-5.09, 0.45)	0.47 (-1.47, 2.41)	0.00
	PFNA, Targon PF	-0.01 (-3.26, 3.28)	-0.05 (-4.16, 3.72)	-0.09 (-2.26, 2.17)	1.00
	SHS, Targon PF	-0.40 (-3.52, 2.35)	-0.45 (-4.51, 3.74)	-0.49 (-2.73, 1.75)	0.99
Operative time	GN, PFN	-6.91 (-32.29, 16.87)	0.20 (-34.99, 35.51)	-3.63 (-22.36, 15.28)	0.71
	GN, PFNA	-3.21 (-26.09, 19.01)	-10.13 (-28.33, 8.59)	-7.27 (-21.44, 6.98)	0.63
	GN, SHS	0.55 (-10.33, 11.32)	3.16 (-19.60, 26.14)	1.36 (-7.91, 10.73)	0.83
	PCCP, PFNA	13.41 (-18.36, 45.62)	-3.34 (-23.98, 18.73)	2.28 (-14.92, 19.87)	0.37
	PCCP, SHS	7.86 (-8.07, 24.33)	24.26 (-11.11, 59.78)	10.92 (-3.13, 25.67)	0.38
	PFN, SHS	2.97 (-21.61, 27.02)	9.70 (-16.41, 36.64)	5.03 (-13.74, 23.87)	0.68
	PFNA, SHS	13.97 (-3.81, 32.25)	3.24 (-14.96, 21.62)	8.68 (-4.38, 21.44)	0.39
	PFNA, Targon PF	18.12 (-15.76, 52.65)	10.94 (-24.14, 45.84)	14.44 (-9.42, 38.48)	0.76
	SHS, Targon PF	3.13 (-28.90, 35.48)	10.28 (-26.46, 46.21)	5.84 (-17.67, 29.78)	0.76
Embolism	GN, PFN	0.50 (-0.92, 2.13)	0.03 (-2.89, 2.77)	0.32 (-0.88, 1.66)	0.71
	GN, SHS	-0.14 (-1.23, 0.72)	0.29 (-2.71, 3.59)	-0.13 (-0.99, 0.73)	0.77
	PFN, SHS	0.27 (-1.41, 1.99)	-1.12 (-3.21, 0.53)	-0.43 (-1.82, 0.82)	0.19
Hospital stay	GN, PCCP	0.06 (-3.32, 3.56)	-0.10 (-3.08, 2.92)	0.04 (-1.94, 1.95)	0.90
	GN, PFN	2.69 (0.87, 4.49)	-1.32 (-4.24, 1.58)	1.72 (-1.10, 3.54)	0.03
	GN, PFNA	0.02 (-2.33, 2.79)	0.19 (-2.85, 3.13)	0.12 (-1.55, 1.89)	0.94
	GN, SHS	-0.67 (-2.66, 1.36)	1.06 (-1.23, 3.46)	0.25 (-1.46, 1.56)	0.23
	PCCP, PFNA	0.85 (-2.79, 4.33)	-0.27 (-3.52, 2.72)	0.08 (-1.87, 2.24)	0.56
	PCCP, SHS	-0.40 (-3.94, 2.86)	0.51 (-2.58, 3.20)	0.21 (-2.01, 2.08)	0.65
	PFN, SHS	0.87 (-1.68, 3.63)	-2.73 (-5.15, -0.83)	-1.45 (-3.58, 1.20)	0.03
	PFNA, SHS	0.38 (-3.11, 3.89)	-0.35 (-3.36, 2.23)	0.13 (-2.00, 1.71)	0.68
Intra-operative fracture	GN, PFN	-1.66 (-4.44, 0.32)	-17.69 (-75.00, 22.45)	-1.65 (-4.17, 0.33)	0.38
	GN, SHS	-1.76 (-3.62, -0.58)	-10.62 (-72.60, 15.79)	-1.83 (-3.60, -0.64)	0.52
	PFN, SHS	-14.98 (-60.71, 2.50)	0.02 (-2.78, 2.64)	-0.15 (-2.81, 2.36)	0.19
Later fracture	GN, PFN	-1.12 (-4.56, 1.53)	14.31 (-0.53, 42.37)	-0.55 (-3.45, 2.00)	0.05
	GN, PFNA	-0.05 (-3.89, 3.50)	-1.29 (-6.82, 3.98)	-0.44 (-3.63, 2.38)	0.70
	GN, SHS	-3.28 (-6.18, -1.18)	-36.42 (-79.26, -3.41)	-3.48 (-6.32, -1.35)	0.05
	PFN, PFNA	-25.68 (-85.42, -0.24)	1.52 (-2.66, 6.24)	0.14 (-3.58, 3.59)	0.13
	PFN, SHS	-27.39 (-79.05, 1.40)	-2.87 (-6.71, 0.51)	-2.90 (-6.70, 0.37)	0.19
	PFNA, SHS	-20.50 (-67.07, -1.00)	-2.24 (-6.41, 1.84)	-3.00 (-6.78, 0.34)	0.11
Mortality	GN, PCCP	1.68 (-0.65, 5.11)	-0.37 (-1.17, 0.36)	-0.18 (-0.91, 0.55)	0.10
	GN, PFN	0.19 (-0.58, 0.98)	0.43 (-0.87, 1.71)	0.23 (-0.38, 0.87)	0.74
	GN, SHS	0.06 (-0.32, 0.42)	0.39 (-0.80, 1.71)	0.09 (-0.27, 0.43)	0.59
	PCCP, SHS	0.43 (-0.24, 1.13)	-1.69 (-4.97, 0.70)	0.27 (-0.38, 0.90)	0.10
	PFN, SHS	-0.32 (-1.58, 0.91)	-0.08 (-0.93, 0.75)	-0.14 (-0.84, 0.51)	0.74
	PFNA, SHS	0.05 (-1.26, 1.31)	-0.00 (-1.76, 1.67)	0.00 (-0.98, 0.95)	0.98
	PFNA, Targon PF	-0.02 (-1.40, 1.39)	0.03 (-1.56, 1.61)	0.00 (-1.00, 1.03)	0.97
	SHS, Targon PF	0.03 (-0.98, 1.05)	-0.01 (-1.89, 1.90)	0.01 (-0.81, 0.86)	0.97
Non-union	GN, PFN	0.82 (-1.88, 4.44)	-6.94 (-38.81, 16.72)	0.79 (-2.04, 4.07)	0.48
	GN, PFNA	0.42 (-1.94, 2.75)	-7.57 (-20.69, -0.62)	-0.76 (-2.76, 1.03)	0.13

	GN, SHS	-0.31 (-1.25, 0.44)	3.43 (-1.24, 8.61)	-0.20 (-0.97, 0.58)	0.10
	PFN, SHS	-3.74 (-47.12, 29.96)	-1.28 (-4.94, 1.82)	-1.02 (-4.35, 1.91)	0.85
	PFNA, SHS	3.45 (-2.03, 20.57)	-0.34 (-2.49, 1.93)	0.56 (-1.31, 2.61)	0.22
	PFNA, Targon PF	8.76 (-0.07, 25.44)	0.10 (-4.16, 4.12)	1.32 (-1.49, 4.98)	0.14
	SHS, Targon PF	0.12 (-3.88, 3.45)	7.68 (-0.71, 23.12)	0.64 (-1.84, 4.24)	0.12
Re-operation	GN, PFN	0.26 (-0.51, 0.92)	0.97 (-0.91, 3.22)	0.32 (-0.34, 0.91)	0.51
	GN, PFNA	15.24 (0.30, 63.68)	-1.82 (-3.42, -0.48)	-1.39 (-2.78, -0.26)	0.11
	GN, SHS	-0.47 (-1.04, 0.04)	-0.41 (-2.21, 1.34)	-0.47 (-0.96, 0.00)	0.92
	PFN, SHS	-0.91 (-2.32, 0.33)	-0.70 (-1.61, 0.28)	-0.79 (-1.48, -0.04)	0.76
	PFNA, SHS	1.79 (0.31, 3.96)	-0.34 (-2.73, 1.87)	0.93 (-0.14, 2.19)	0.11
	PFNA, Targon PF	-1.00 (-3.13, 0.94)	-0.06 (-2.07, 2.37)	-0.55 (-1.79, 0.88)	0.42
	SHS, Targon PF	-1.12 (-2.83, 0.20)	-2.17 (-5.58, 0.31)	-1.42 (-2.88, -0.29)	0.46
Wound infection	GN, PFN	-0.19 (-1.30, 1.14)	1.88 (-0.85, 5.33)	0.01 (-0.92, 1.31)	0.17
	GN, PFNA	2.03 (-0.25, 5.26)	-0.09 (-1.98, 1.82)	0.65 (-0.61, 2.22)	0.16
	GN, SHS	0.28 (-0.55, 1.31)	0.23 (-1.78, 2.59)	0.20 (-0.44, 1.13)	0.95
	PFN, SHS	-0.69 (-3.10, 1.48)	0.44 (-1.12, 1.91)	0.21 (-1.01, 1.34)	0.36
	PFNA, SHS	0.82 (-1.24, 2.85)	-1.36 (-3.40, 0.50)	-0.40 (-1.85, 0.85)	0.12
	PFNA, Targon PF	-0.97 (-3.63, 1.48)	-0.32 (-3.17, 2.39)	-0.55 (-2.36, 1.06)	0.71
	SHS, Targon PF	-0.01 (-2.18, 2.08)	-0.41 (-3.62, 2.36)	-0.17 (-1.77, 1.41)	0.82

GN: Gamma Nail; SHS: Sliding Hip Screw; PFN: Proximal Femoral Nail; PFNA: Proximal Femoral Nail Antirotation; PCCP: Percutaneous Compression Plate; Targon PF: Targon Proximal Femoral.

Table 3. Comparison of different therapies in blood loss (A), cut out (B), operative time (C), embolism (D), hospital stay (E), intra-operative fracture (F), later fracture (G), mortality (H), non-union (I), re-operation (J) and wound infection (K)

(A)					
GN	-108.27 (-294.65, 78.33)		-128.68 (-285.51, 28.16)	54.62 (-61.73, 173.05)	
108.27 (-78.33, 294.65)	PCCP		-20.18 (-192.11, 144.75)	162.87 (9.50, 315.27)	
128.68 (-28.16, 285.51)	20.18 (-144.75, 192.11)		PFNA	183.12 (53.11, 315.67)	
-54.62 (-173.05, 61.73)	-162.87 (-315.27, -9.50)		-183.12 (-315.67, -53.11)	SHS	
(B)					
GN	0.18 (0.01, 2.53)	0.61 (0.16, 1.76)	2.21 (0.11, 105.24)	0.55 (0.27, 1.17)	0.22 (0.01, 5.33)
5.54 (0.40, 143.85)	PCCP	7.18 (0.45, 255.45)	0.90 (0.07, 28.94)	4.10 (0.59, 50.17)	1.18 (0.04, 43.74)
1.65 (0.57, 6.17)	0.14 (0.00, 2.25)	PFN	0.12 (0.00, 3.50)	0.64 (0.05, 5.17)	0.14 (0.00, 5.38)
0.45 (0.01, 9.20)	1.11 (0.03, 15.09)	8.37 (0.29, 236.65)	PFNA	4.94 (0.40, 44.42)	1.24 (0.12, 14.42)
1.82 (0.86, 3.72)	0.24 (0.02, 1.69)	1.56 (0.19, 21.32)	0.20 (0.02, 2.48)	SHS	0.49 (0.04, 4.18)
4.56 (0.19, 140.95)	0.85 (0.02, 24.36)	7.39 (0.19, 254.46)	0.81 (0.07, 8.45)	2.05 (0.24, 23.21)	Targon PF
(C)					
GN	-9.50 (-26.87, 7.15)	-3.63 (-22.36, 15.28)	-7.27 (-21.44, 6.98)	1.36 (-7.91, 10.73)	7.05 (-17.34, 32.53)
9.50 (-7.15, 26.87)	PCCP	5.95 (-17.92, 29.77)	2.28 (-14.92, 19.87)	10.92 (-3.13, 25.67)	16.73 (-10.40, 43.86)
3.63 (-15.28, 22.36)	-5.95 (-29.77, 17.92)	PFN	-3.71 (-26.03, 18.58)	5.03 (-13.74, 23.87)	10.60 (-18.81, 41.43)
7.27 (-6.98, 21.44)	-2.28 (-19.87, 14.92)	3.71 (-18.58, 26.03)	PFNA	8.68 (-4.38, 21.44)	14.44 (-9.42, 38.48)
-1.36 (-10.73, 7.91)	-10.92 (-25.67, 3.13)	-5.03 (-23.87, 13.74)	-8.68 (-21.44, 4.38)	SHS	5.84 (-17.67, 29.78)
-7.05 (-32.53, 17.34)	-16.73 (-43.86, 10.40)	-10.60 (-41.43, 18.81)	-14.44 (-38.48, 9.42)	-5.84 (-29.78, 17.67)	Targon PF
(D)					
GN	1.37 (0.41, 5.26)			0.88 (0.37, 2.07)	
0.73 (0.19, 2.42)	PFN			0.65 (0.16, 2.28)	
1.14 (0.48, 2.70)	1.53 (0.44, 6.17)			SHS	
(E)					
GN	0.06 (-1.84, 2.10)	2.36 (-0.54, 4.11)	0.01 (-1.51, 1.96)	-0.14 (-1.98, 1.50)	
-0.06 (-2.10, 1.84)	PCCP	0.86 (-2.48, 3.89)	0.40 (-1.80, 2.47)	0.09 (-2.57, 2.27)	
-2.36 (-4.11, 0.54)	-0.86 (-3.89, 2.48)	PFN	-0.40 (-3.50, 2.76)	-0.08 (-2.96, 2.68)	
-0.01 (-1.96, 1.51)	-0.40 (-2.47, 1.80)	0.40 (-2.76, 3.50)	PFNA	0.34 (-1.82, 2.19)	
0.14 (-1.50, 1.98)	-0.09 (-2.27, 2.57)	0.08 (-2.68, 2.96)	-0.34 (-2.19, 1.82)	SHS	

(F)					
GN		0.19 (0.02, 1.40)		0.16 (0.03, 0.53)	
5.19 (0.72, 64.52)		PFN		0.86 (0.06, 10.58)	
6.22 (1.89, 36.43)		1.16 (0.09, 16.58)		SHS	
(G)					
GN		0.57 (0.03, 7.40)	0.64 (0.03, 10.82)	0.03 (0.00, 0.26)	
1.74 (0.14, 31.37)		PFN	1.15 (0.03, 36.36)	0.05 (0.00, 1.45)	
1.56 (0.09, 37.54)		0.87 (0.03, 35.92)	PFNA	0.05 (0.00, 1.41)	
32.32 (3.87, 554.47)		18.22 (0.69, 813.90)	20.01 (0.71, 883.96)	SHS	
(H)					
GN	0.83 (0.40, 1.73)	1.26 (0.69, 2.38)	1.08 (0.39, 3.06)	1.09 (0.76, 1.53)	1.11 (0.45, 2.74)
1.20 (0.58, 2.47)	PCCP	1.50 (0.61, 3.88)	1.33 (0.40, 4.34)	1.31 (0.68, 2.47)	1.32 (0.46, 3.89)
0.79 (0.42, 1.46)	0.67 (0.26, 1.65)	PFN	0.87 (0.27, 2.81)	0.87 (0.43, 1.66)	0.88 (0.30, 2.52)
0.92 (0.33, 2.56)	0.75 (0.23, 2.49)	1.15 (0.36, 3.74)	PFNA	1.00 (0.37, 2.58)	1.01 (0.37, 2.81)
0.92 (0.65, 1.31)	0.76 (0.41, 1.47)	1.15 (0.60, 2.31)	1.00 (0.39, 2.67)	SHS	1.01 (0.45, 2.36)
0.90 (0.37, 2.23)	0.76 (0.26, 2.18)	1.13 (0.40, 3.34)	1.00 (0.36, 2.71)	0.99 (0.42, 2.24)	Targon PF
(I)					
GN	2.21 (0.13, 58.27)	0.47 (0.06, 2.80)	0.82 (0.38, 1.79)	1.48 (0.12, 58.80)	
0.45 (0.02, 7.66)	PFN	0.18 (0.00, 5.96)	0.36 (0.01, 6.74)	0.63 (0.01, 89.85)	
2.15 (0.36, 15.85)	5.63 (0.17, 204.53)	PFNA	1.74 (0.27, 13.57)	3.74 (0.23, 145.62)	
1.23 (0.56, 2.65)	2.77 (0.15, 77.15)	0.57 (0.07, 3.70)	SHS	1.90 (0.16, 69.08)	
0.67 (0.02, 8.32)	1.60 (0.01, 72.36)	0.27 (0.01, 4.43)	0.53 (0.01, 6.30)	Targon PF	
(J)					
GN	1.37 (0.71, 2.48)	0.25 (0.06, 0.77)	0.62 (0.38, 1.00)	0.15 (0.03, 0.53)	
0.73 (0.40, 1.40)	PFN	0.18 (0.04, 0.65)	0.45 (0.23, 0.96)	0.10 (0.02, 0.44)	
4.03 (1.29, 16.10)	5.59 (1.54, 24.41)	PFNA	2.54 (0.87, 8.92)	0.58 (0.17, 2.41)	
1.60 (1.00, 2.61)	2.21 (1.04, 4.39)	0.39 (0.11, 1.14)	SHS	0.24 (0.06, 0.75)	
6.73 (1.88, 30.11)	9.55 (2.26, 42.59)	1.73 (0.42, 5.99)	4.13 (1.34, 17.84)	Targon PF	
(K)					
GN	1.01 (0.40, 3.70)	1.92 (0.54, 9.17)	1.23 (0.64, 3.09)	1.02 (0.21, 6.91)	
0.99 (0.27, 2.50)	PFN	1.81 (0.36, 11.52)	1.23 (0.36, 3.83)	1.04 (0.14, 7.46)	
0.52 (0.11, 1.84)	0.55 (0.09, 2.81)	PFNA	0.67 (0.16, 2.34)	0.58 (0.09, 2.88)	
0.81 (0.32, 1.56)	0.81 (0.26, 2.75)	1.49 (0.43, 6.37)	SHS	0.85 (0.17, 4.09)	
0.98 (0.14, 4.72)	0.96 (0.13, 6.99)	1.73 (0.35, 10.59)	1.18 (0.24, 5.88)	Targon PF	

GN: Gamma Nail; SHS: Sliding Hip Screw; PFN: Proximal Femoral Nail; PFNA: Proximal Femoral Nail Antirotation; PCCP: Percutaneous Compression Plate; Targon PF: Targon Proximal Femoral

time (**Figure 5A**), mortality (**Figure 5B**), nonunion (**Figure 5C**), reoperation (**Figure 5D**), and wound infection (**Figure 5E**) into consideration. These were not totally in accordance with the results of the point estimates and credible intervals.

Subgroup analysis

Of the included studies, more than half were both stable and unstable, 10 studies were unstable, and 1 was stable. Thus, a network meta-analysis of the 10 unstable studies was conducted.

For blood loss, it did not meet the consistency (intraindividual standard deviation [ISD], 125.11; 95% CI, -6.80 to 246.76). Thus, the inconsistency model was used for the analysis. A PSRF value of 1.00 suggested a complete convergence and stable result. The blood loss results showed that PFN was associated with the least blood loss, and no significant difference was found between PFN and GN, PFNA, or SHS (Table S1).

For cut-out incidence, the inconsistency model was used for the analysis (Table S2). A PSRF value of 1.00-1.03 suggested a complete convergence and stable result. The cut-out results indicated that the incidence of PFN was the lowest, with no significant differences among the therapies (Table S3).

For operative time, the consistency model was used for the analysis (Table S4). The PSRF value was between 1.00 and 1.02, which showed a complete convergence and stable

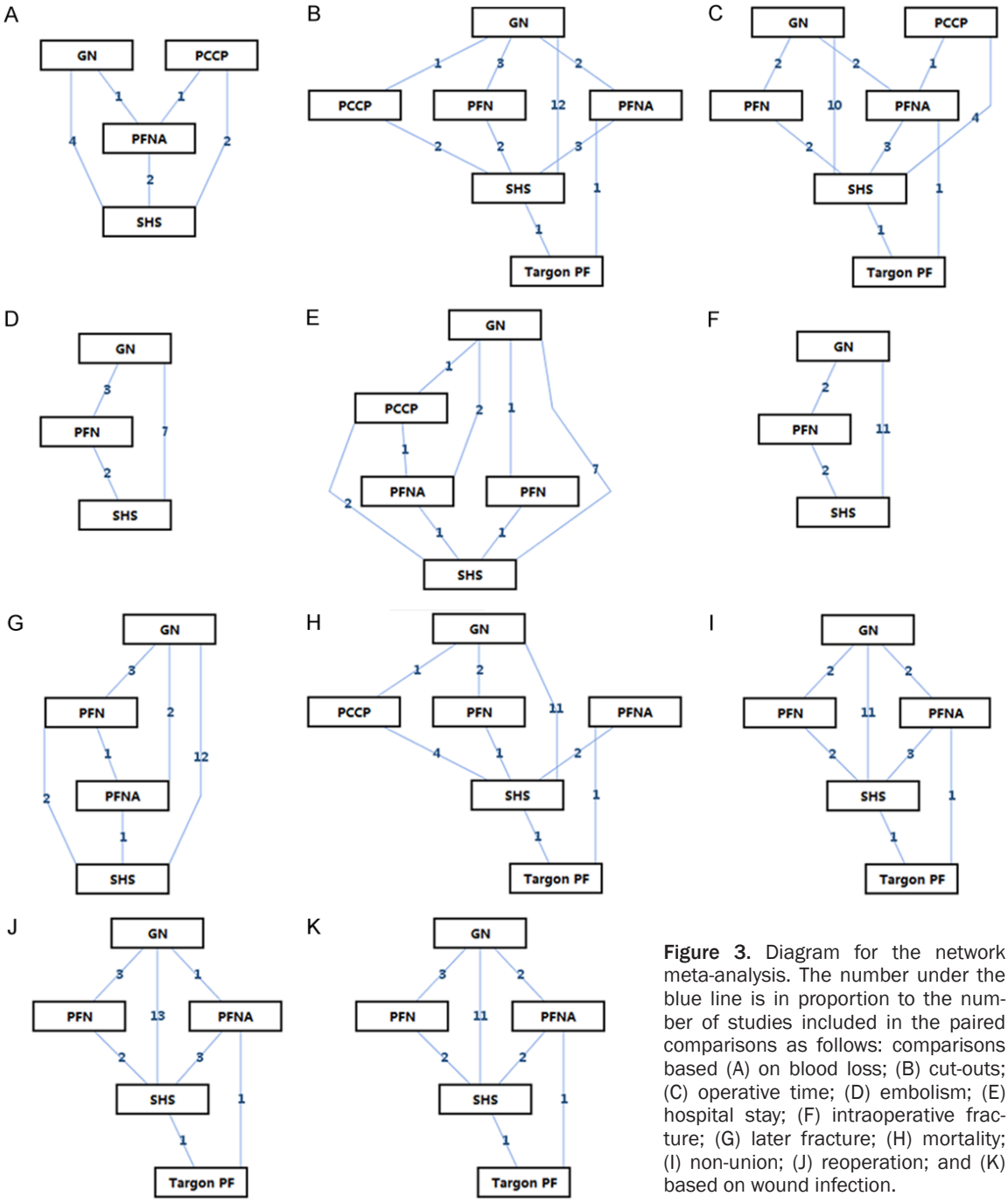

Figure 3. Diagram for the network meta-analysis. The number under the blue line is in proportion to the number of studies included in the paired comparisons as follows: comparisons based (A) on blood loss; (B) cut-outs; (C) operative time; (D) embolism; (E) hospital stay; (F) intraoperative fracture; (G) later fracture; (H) mortality; (I) non-union; (J) reoperation; and (K) based on wound infection.

result. The operative time results suggested that PFN had the shortest operative time, with no significant differences among GN, SHS, and PFNA (Table S5).

For embolism, it met the consistency (ISD, 0.58; 95% CI, 0.03-1.13). The PSRF value was between 1.00 and 1.03, indicating a complete convergence and stable result. The embolism results showed that the incidence of GN was the lowest, with no significant difference between PFN and SHS (Table S6).

For hospital stay, the consistency model was used for the analysis (Table S7). A PSRF value of 1.00-1.04 suggested a complete convergence and stable result. The hospital stay results indicated no significant difference among these therapies, but the hospital stay for SHS was the shortest (Table S8).

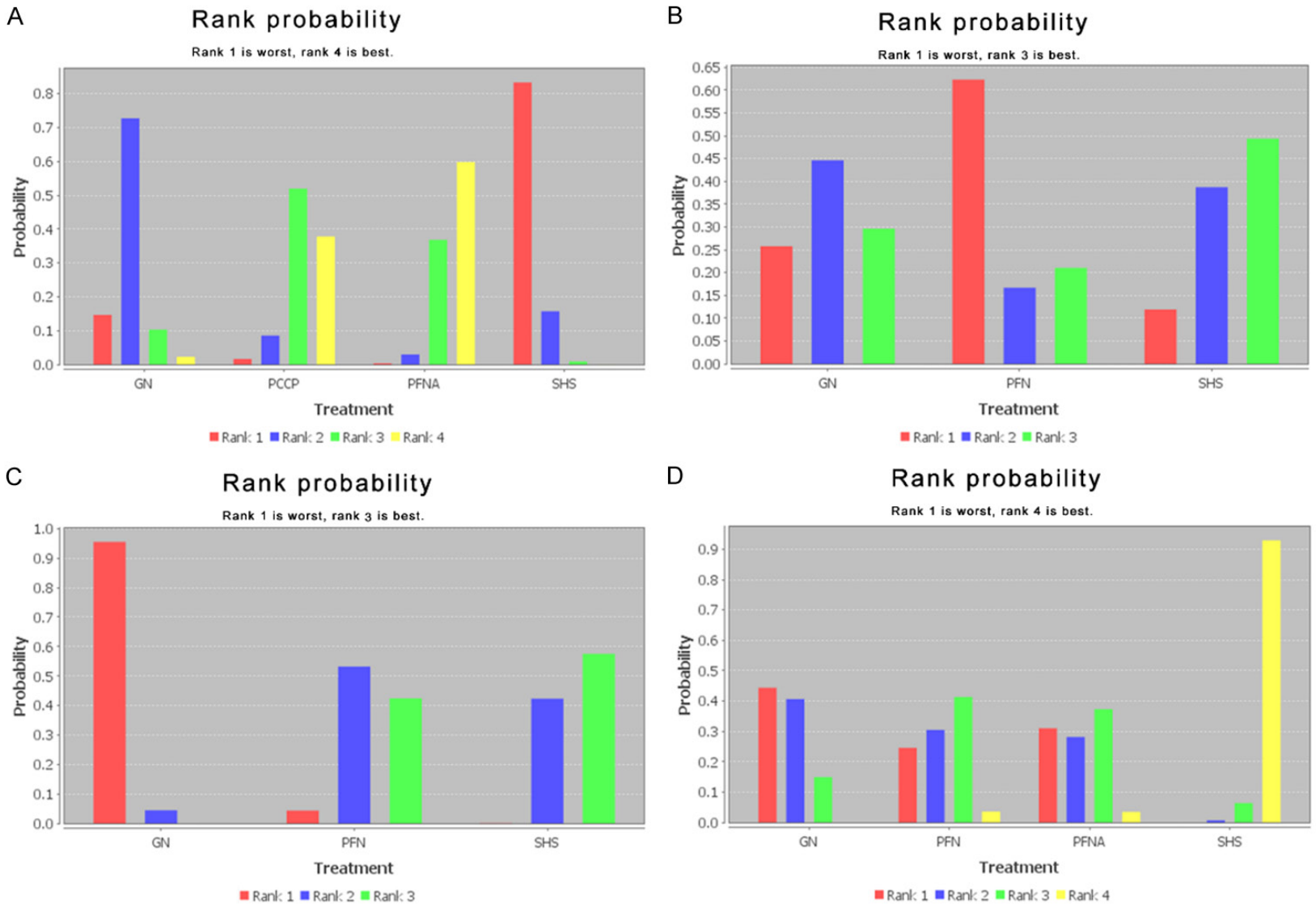

Figure 4. Rank probability in blood loss (A), embolism (B), intraoperative fracture (C), and later fracture (D).

For mortality, it met the inconsistency (ISD, 0.31; 95% CI, 0.02-0.59). Thus, the inconsistency model was used for the analysis. A PSRF value of 1.00-1.04 suggested a complete convergence and stable result. The mortality results showed that the mortality with PFNA was the lowest, but no significant difference in mortality was found among GN, SHS, and PFN (Table S9).

For nonunion, the consistency model was used for the analysis (Table S10). The PSRF value was between 1.00 and 1.03, which suggested a complete convergence and stable result. The nonunion results indicated that SHS had the lowest incidence for nonunion, but no significant differences in nonunion were observed among GN, PFNA, and PFN (Table S11).

For reoperation, the inconsistency model was used for the analysis (Table S12). A PSRF value of 1.00-1.03 indicated a complete convergence and stable result. The reoperation results showed that the incidence of reoperation with GN was the lowest, but no significant difference was found when compared with those in other therapies (Table S13).

For wound infection, the consistency model was used for the analysis (Table S14). The PSRF value was between 1.00 and 1.04, which suggested a complete convergence and stable result. The wound infection results indicated that the incidence of wound infection with PFN was the lowest, but no significant difference was found among the several therapies, including GN, SHS, and PFNA (Table S15).

Taken together, the incidences of blood loss, cut-out, and wound infection were lowest and the operative time was shortest with PFN. The incidences of embolism and reoperation with GN were the lowest. Hospital stay was shortest and the incidence of reoperation was lowest with for SHS. Mortality after operation was lowest with PFNA, but the difference was not significant. Therefore, each method had its advantages and disadvantages, but PFN might be the best treatment option for unstable femoral intertrochanteric fractures.

Discussion

In the current network meta-analysis, 31 eligible studies were included to assess different indicators of the usefulness of GN, SHS, PFN, PFNA, PCCP, and Targon PF for the treatment of femoral intertrochanteric fractures. The results of the multiple comparisons indicated that PFNA (blood loss and nonunion), PCCP (operative time and mortality), SHS (embolism, intraoperative fracture, and later fracture), or Targon PF (reoperation and wound infection) was the optimal choice for internal fixation treatment of femoral intertrochanteric fractures based on the different indicators. The results of the rank probability showed that SHS was the best among the therapies in consideration of blood loss, embolism, intraoperative fracture, and later fracture, while Targon PF was the best among the therapies when taking operative time, mortality, nonunion, reoperation, and wound infection into consideration. These results were not totally inconsistent. The subgroup analysis revealed that PFN might be a better treatment option for unstable femoral intertrochanteric fractures.

On the one hand, Garg *et al.* compared the treatment outcomes of PFNA and DHS for unstable trochanteric fractures and found that patients treated with PFNA had superior outcomes as compared with those treated with DHS in terms of lower blood loss and shorter operative time [43]. Compared with hemiarthroplasty, PFNA is better for patients with intertrochanteric fractures according to the operative statistics, including blood loss, operation lasting time, anesthesia, drainage, and blood transfusion [50]. In consideration of postoperative pain and operation time, the minimal invasive treatment with PCCP is better than DHS for the treatment of pertrochanteric hip fractures [39]. A previous study demonstrated that PCCP had some advantages (e.g., a shorter operative time) over the compression hip screw for the treatment of intertrochanteric hip fractures, although mortality rates, implant failure, and length of hospitalization had no significant differences and the success rates in fracture fixation were similar between the two groups [51]. Compared with SHS, PCCP contributes to the improvement of the ability to walk independently, reduces pain with activity, and improves quality of life based on multiple scales of the Short Form 36, and has significant advantages in regard to operating times, incision length, and blood loss [19]. Targon PF has no intraoperative femoral fractures, no cut-out incidence or nonunion, and low incidence rate of reoperation; therefore, it is better than

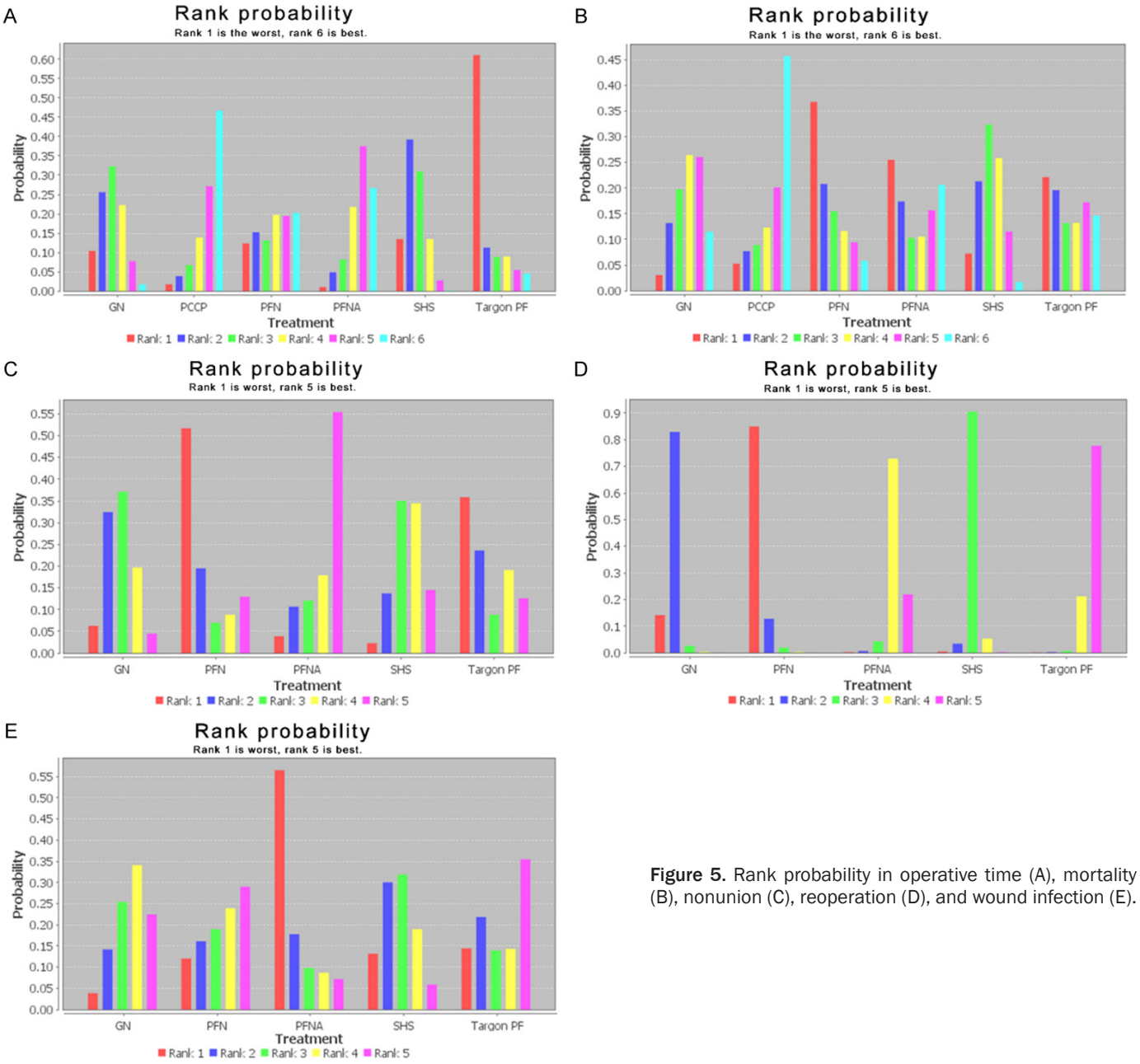

Figure 5. Rank probability in operative time (A), mortality (B), nonunion (C), reoperation (D), and wound infection (E).

other intramedullary systems for treating proximal femoral fractures [11]. These research findings are in line with our findings to some degree.

On the other hand, Kosygan *et al.* performed a prospective randomized trial in patients with intertrochanteric hip fracture treated with PCCP or the classic hip screw, and found that the PCCP group required less blood loss and transfusion, had a significantly longer operating time, and had the same mortality rate [38]. While SHS can lead to a significant mortality in patients with trochanteric fractures, its overall reoperation rate is low, and the final outcome of survivors treated with SHS is good, with the accommodation and mobility of most patients recovering to their initial level [52]. For femoral intertrochanteric fractures, Targon PF may be a promising implant in terms of clinical recovery (e.g., transfusion rate, operating time, pain analysis, and functional evaluation), radiological parameters (e.g., union time), and early ambulation [53]. These research findings are inconsistent with our results, which may be induced by incomplete inclusion and assessment of various therapies for femoral intertrochanteric fracture.

In addition, in our present meta-analysis, the subgroup analysis revealed that PFN might be a better treatment option for unstable femoral intertrochanteric fractures. Al-Yassari *et al.* suggested that PFN with a biomechanically stable construct and relatively easy procedure was a useful device in the treatment of unstable trochanteric femoral fractures [54]. Papasimos *et al.* indicated that PFN was a minimally invasive implant for unstable proximal femoral fractures, but future modifications to reduce its high complication rate are needed [32]. Our present results matched with these previous findings and suggested that for the treatment of unstable femoral intertrochanteric fracture, PFN might be a better method.

The present study used network meta-analysis to perform comprehensive comparisons among GN, SHS, PFN, PFNA, PCCP, and Targon PF based on different indicators. However, the following limitations should be considered: i) inconsistency models were used for some indicators, and rank probability diagrams could not be made owing to the potential confounders and incomplete data in the enrolled studies; ii) some studies were excluded for their therapeutic methods not forming a closed loop with GN, SHS, PFN, PFNA, PCCP, and Targon PF, which resulted in an incomplete assessment of different therapies for femoral intertrochanteric fracture; and iii) by using the ADDIS software, only the random-effect model could be applied, which might have led to conservative results.

In conclusion, no optimal internal fixation treatment was identified for femoral intertrochanteric fracture, but PFN may be a better treatment option for unstable femoral intertrochanteric fracture. However, more studies are needed in the future.

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Disclosure of conflict of interest

None.

Abbreviations

GN, Gamma Nail; SHS, Sliding Hip Screw; PFN, Proximal Femoral Nail; PFNA, Proximal Femoral Nail Antirotation; PCCP, Percutaneous Compression Plate; Targon PF, Targon Proximal Femoral; RCT, randomized controlled trial; ADDIS, Aggregate Data Drug Information System; MCMC, Markov Chain Monte Carlo; OR, odds ratio; SMD, standardized mean difference; CI, confidence interval; PSRF, potential scale reduction factor; CHS, compression hip screw.

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Table S1. Meta-analysis of blood loss

GN	-66.46 (-374.61, 252.90)	-54.18 (-371.41, 263.89)	197.28 (-256.15, 633.94)
66.46 (-252.90, 374.61)	PFN	11.95 (-437.91, 461.92)	263.60 (-297.75, 804.99)
54.18 (-263.89, 371.41)	-11.95 (-461.92, 437.91)	PFNA	252.08 (-67.24, 560.27)
-197.28 (-633.94, 256.15)	-263.60 (-804.99, 297.75)	-252.08 (-560.27, 67.24)	SHS

Gamma Nail (GN), Sliding Hip Screw (SHS), Proximal Femoral Nail (PFN), Proximal Femoral Nail Antirotation (PFNA).

Table S2. Node-splitting analysis of cut out incidence

Name	Direct effect	Indirect effect	Overall	*P*-Value
GN, PFNA	11.67 (1.18, 24.68)	-16.71 (-62.48, -2.13)	-0.12 (-3.71, 4.01)	<0.01
GN, SHS	-0.37 (-2.65, 1.76)	23.55 (5.57, 70.73)	0.76 (-1.78, 3.64)	<0.01
PFN, SHS	0.76 (-3.93, 5.70)	2.27 (-2.13, 7.31)	1.46 (-1.55, 5.04)	0.60
PFNA, SHS	11.88 (1.81, 33.89)	-14.56 (-45.60, -1.42)	0.83 (-2.99, 4.71)	<0.01

Gamma Nail (GN), Sliding Hip Screw (SHS), Proximal Femoral Nail (PFN), Proximal Femoral Nail Antirotation (PFNA).

Table S3. Comparison of cut out incidence for different therapies

GN	0.74 (0.06, 3.82)	3.99 (0.05, 100.38)	1.74 (0.08, 20.95)
1.36 (0.26, 16.61)	PFN	0.40 (0.01, 60.89)	2.80 (0.30, 101.47)
0.25 (0.01, 20.56)	2.53 (0.02, 80.62)	PFNA	10.12 (0.14, 297.04)
0.57 (0.05, 13.19)	0.36 (0.01, 3.37)	0.10 (0.00, 7.26)	SHS

Gamma Nail (GN), Sliding Hip Screw (SHS), Proximal Femoral Nail (PFN), Proximal Femoral Nail Antirotation (PFNA).

Table S4. Node-splitting analysis of operative time

Name	Direct effect	Indirect effect	Overall	*P*-Value
GN, PFNA	-3.28 (-31.07, 24.74)	10.91 (-28.37, 49.93)	1.22 (-21.87, 23.75)	0.52
GN, SHS	10.70 (-19.11, 39.50)	-2.91 (-43.07, 38.01)	6.32 (-16.19, 28.83)	0.54
PFN, SHS	5.32 (-34.07, 48.57)	20.57 (-17.69, 61.62)	10.62 (-20.91, 42.59)	0.55
PFNA, SHS	0.54 (-27.24, 28.74)	14.59 (-25.98, 52.82)	5.08 (-17.21, 27.86)	0.53

Gamma Nail (GN), Sliding Hip Screw (SHS), Proximal Femoral Nail (PFN), Proximal Femoral Nail Antirotation (PFNA).

Table S5. Comparison of operative time for different therapies

GN	-4.44 (-32.43, 22.26)	1.22 (-21.87, 23.75)	6.32 (-16.19, 28.83)
4.44 (-22.26, 32.43)	PFN	5.66 (-27.86, 39.31)	10.62 (-20.91, 42.59)
-1.22 (-23.75, 21.87)	-5.66 (-39.31, 27.86)	PFNA	5.08 (-17.21, 27.86)
-6.32 (-28.83, 16.19)	-10.62 (-42.59, 20.91)	-5.08 (-27.86, 17.21)	SHS

Gamma Nail (GN), Sliding Hip Screw (SHS), Proximal Femoral Nail (PFN), Proximal Femoral Nail Antirotation (PFNA).

Table S6. Comparison of embolism incidence for different therapies

GN	2.31 (0.53, 11.54)	3.53 (0.47, 33.83)
0.43 (0.09, 1.89)	PFN	1.59 (0.22, 12.13)
0.28 (0.03, 2.13)	0.63 (0.08, 4.47)	SHS

Gamma Nail (GN), Sliding Hip Screw (SHS), Proximal Femoral Nail (PFN).

Table S7. Node-splitting analysis of hospital stay

Name	Direct effect	Indirect effect	Overall	*P*-Value
GN, PFNA	-0.00 (-3.22, 3.81)	-3.47 (-10.38, 3.46)	-0.22 (-3.39, 2.49)	0.29
GN, SHS	-3.14 (-8.00, 2.21)	0.40 (-5.31, 6.98)	-0.27 (-5.07, 2.43)	0.31
PFNA, SHS	0.34 (-4.26, 4.99)	-3.06 (-9.65, 3.09)	-0.02 (-4.52, 2.63)	0.38

Gamma Nail (GN), Sliding Hip Screw (SHS), Proximal Femoral Nail Antirotation (PFNA).

Table S8. Comparison of hospital stays for different therapies

GN	2.70 (-1.68, 7.22)	-0.22 (-3.39, 2.49)	-0.27 (-5.07, 2.43)
-2.70 (-7.22, 1.68)	PFN	-2.93 (-8.28, 2.18)	-2.92 (-9.75, 1.80)
0.22 (-2.49, 3.39)	2.93 (-2.18, 8.28)	PFNA	-0.02 (-4.52, 2.63)
0.27 (-2.43, 5.07)	2.92 (-1.80, 9.75)	0.02 (-2.63, 4.52)	SHS

Gamma Nail (GN), Sliding Hip Screw (SHS), Proximal Femoral Nail (PFN), Proximal Femoral Nail Antirotation (PFNA).

Table S9. Comparison of mortality for different therapies

GN	1.19 (0.67, 2.15)	0.68 (0.16, 2.64)	0.65 (0.31, 1.42)
0.84 (0.47, 1.49)	PFN	0.55 (0.13, 2.47)	0.54 (0.21, 1.43)
1.47 (0.38, 6.21)	1.80 (0.41, 7.98)	PFNA	1.00 (0.30, 3.10)
1.53 (0.70, 3.19)	1.85 (0.70, 4.71)	1.00 (0.32, 3.32)	SHS

Gamma Nail (GN), Sliding Hip Screw (SHS), Proximal Femoral Nail (PFN), Proximal Femoral Nail Antirotation (PFNA).

Table S10. Node-splitting analysis of non-union

Name	Direct effect	Indirect effect	Overall	*P*-Value
GN, PFNA	0.23 (-1.77, 2.45)	-2.93 (-13.59, 5.90)	0.32 (-1.69, 2.92)	0.54
GN, SHS	-0.16 (-3.97, 2.92)	-3.32 (-17.22, 4.63)	-0.30 (-3.31, 2.52)	0.52
PFNA, SHS	-5.48 (-15.72, 5.54)	-0.44 (-4.06, 2.77)	-0.69 (-3.96, 2.49)	0.36

Gamma Nail (GN), Sliding Hip Screw (SHS), Proximal Femoral Nail Antirotation (PFNA).

Table S11. Comparison of non-union incidence for different therapies

GN	2.23 (0.16, 48.71)	1.37 (0.18, 18.48)	0.74 (0.04, 12.45)
0.45 (0.02, 6.10)	PFN	0.68 (0.02, 14.74)	0.35 (0.00, 20.67)
0.73 (0.05, 5.42)	1.47 (0.07, 53.16)	PFNA	0.50 (0.02, 12.02)
1.36 (0.08, 27.32)	2.85 (0.05, 381.33)	2.00 (0.08, 52.20)	SHS

Gamma Nail (GN), Sliding Hip Screw (SHS), Proximal Femoral Nail (PFN), Proximal Femoral Nail Antirotation (PFNA).

Table S12. Node-splitting analysis of re-operation

Name	Direct effect	Indirect effect	Overall	*P*-Value
GN, PFNA	13.57 (-0.36, 43.89)	-1.48 (-5.00, 1.91)	-0.49 (-3.41, 2.99)	0.04
GN, SHS	-0.05 (-1.96, 2.38)	10.82 (0.30, 50.92)	0.31 (-1.48, 2.80)	0.05
PFN, SHS	-0.56 (-4.44, 3.17)	0.76 (-2.58, 5.27)	-0.00 (-2.23, 2.77)	0.54
PFNA, SHS	1.45 (-1.15, 4.70)	-23.33 (-60.49, 0.29)	0.81 (-1.92, 3.62)	0.03

Gamma Nail (GN), Sliding Hip Screw (SHS), Proximal Femoral Nail (PFN), Proximal Femoral Nail Antirotation (PFNA).

Table S13. Comparison of re-operation incidence for different therapies

GN	1.35 (0.22, 9.64)	1.08 (0.04, 77.43)	1.20 (0.16, 20.32)
0.74 (0.10, 4.50)	PFN	0.37 (0.02, 21.66)	0.95 (0.10, 18.28)
0.93 (0.01, 27.93)	2.69 (0.05, 63.22)	PFNA	2.57 (0.16, 35.85)
0.83 (0.05, 6.35)	1.05 (0.05, 9.78)	0.39 (0.03, 6.07)	SHS

Gamma Nail (GN), Sliding Hip Screw (SHS), Proximal Femoral Nail (PFN), Proximal Femoral Nail Antirotation (PFNA).

Table S14. Node-splitting analysis of wound infection

Name	Direct effect	Indirect effect	Overall	*P*-Value
GN, PFNA	2.03 (-0.43, 5.99)	-0.35 (-5.71, 5.03)	1.43 (-0.70, 4.04)	0.41
GN, SHS	0.89 (-3.05, 5.23)	3.59 (-0.76, 8.61)	1.89 (-0.84, 5.04)	0.36
PFN, SHS	0.74 (-3.66, 5.10)	3.48 (-1.46, 8.46)	1.89 (-1.05, 4.94)	0.39
PFNA, SHS	1.37 (-1.75, 4.88)	-1.48 (-7.08, 3.30)	0.44 (-2.04, 3.21)	0.32

Gamma Nail (GN), Sliding Hip Screw (SHS), Proximal Femoral Nail (PFN), Proximal Femoral Nail Antirotation (PFNA).

Table S15. Comparison of wound infection incidence for different therapies

GN	0.95 (0.26, 7.27)	4.16 (0.50, 57.10)	6.65 (0.43, 154.36)
1.06 (0.14, 3.91)	PFN	4.32 (0.27, 66.05)	6.63 (0.35, 139.93)
0.24 (0.02, 2.01)	0.23 (0.02, 3.67)	PFNA	1.55 (0.13, 24.84)
0.15 (0.01, 2.31)	0.15 (0.01, 2.86)	0.64 (0.04, 7.66)	SHS

Gamma Nail (GN), Sliding Hip Screw (SHS), Proximal Femoral Nail (PFN), Proximal Femoral Nail Antirotation (PFNA).