Original Article
Yonsei Med J 2022 Aug;63(8):744-750
https://doi.org/10.3349/ymj.2022.63.8.744

Yonsei Medical Journal
YMJ
pISSN: 0513-5796 · eISSN: 1976-2437

Cephalomedullary Nailing versus Dynamic Hip Screw Fixation in Basicervical Femoral Neck Fracture: A Systematic Review and Meta-Analysis

Yong-Cheol Yoon[1]*, Chul-Ho Kim[2]*, Yong Chan Kim[3], and Hyung Keun Song[4]

[1]Orthopedic Trauma Division, Trauma Center, Gachon University College of Medicine, Incheon;
[2]Department of Orthopaedic Surgery, Chung-Ang University Hospital, Chung-Ang University College of Medicine, Seoul;
[3]Department of Orthopaedic Surgery, Gachon University College of Medicine, Incheon;
[4]Department of Orthopedic Surgery, Ajou University School of Medicine, Suwon, Korea.

Purpose: Although many studies have reported the use of dynamic hip screws (DHS) and cephalomedullary nailing (CMN) for basicervical femoral neck fracture (BFNF), no clear treatment protocols have been recommended. The present study aimed to compare the surgical outcomes associated with DHS and CMN to determine the appropriate fixation method for BFNF.
Materials and Methods: We systematically searched MEDLINE, Embase, and the Cochrane Library for studies published up to January 9, 2021 that compared the treatment outcomes between CMN and DHS in BFNF. The primary outcomes of the present meta-analysis were fracture union time, postoperative cut-out rate, and reoperation rate.
Results: We included seven studies involving 353 cases of BFNF in our review. Of these, 206 patients were treated using CMN, and DHS were utilized in 147 patients. In a pooled analysis, the DHS group required a longer time to achieve fracture union compared to the CMN group [mean difference (MD): -0.41; 95% confidence interval (CI): -0.70, -0.12; p=0.006; I^2=0%]. However, the cut-out and reoperation rates exhibited no statistically significant differences between the DHS and CMN groups [cut-out odds ratio (OR): 0.54; 95% CI: 0.10, 2.82; p=0.47; I^2=24%, reoperation rate OR: 0.65; 95% CI: 0.15, 2.86; p=0.57; I^2=19%, respectively].
Conclusion: Stable fixation using DHS and CMN does not show a significant clinical or radiographical difference in BFNF, and the implant can be selected based on the surgeon's preference.

Key Words: Femoral neck fractures, osteosynthesis, meta-analysis

INTRODUCTION

With increased life expectancy and improvement in medical technology, the elderly population has also increased, with a concomitant increase in the incidence of hip fractures. Globally, the number of patients with hip fractures was 1700000 in 1990 and is expected to reach 6300000 by 2050.[1,2] Complications are common in elderly patients due to underlying cardiovascular diseases and reduced lung function, and the mortality rate has reached 20% even in 1-year follow-up studies.[3] In addition, the incidence of hip fractures exhibits a bimodal distribution, occurring due to high-intensity injuries, such as in car accidents or falls in the young.[4]

Hip fractures can be divided into two main categories as follows: femoral neck fractures and intertrochanteric fractures. This anatomical classification is based on the anatomical location of the fracture line.[5] The selection of implant depends on the level of displacement of the fracture, instability of the fracture, patient age, and systemic conditions. Cancellous cannulated screws (CCS) or arthroplasty may be used for femoral neck

Received: February 17, 2022 **Revised:** May 7, 2022
Accepted: May 26, 2022
Corresponding author: Hyung Keun Song, MD, Department of Orthopedic Surgery, Ajou University School of Medicine, 164 World Cup-ro, Yongtong-gu, Suwon 16499, Korea.
Tel: +82-31-219-5220, Fax: +82-31-219-5229, E-mail: ostrauma@ajou.ac.kr

*Yong-Cheol Yoon and Chul-Ho Kim contributed equally to this work.
•The authors have no potential conflicts of interest to disclose.

fracture, and intertrochanteric fractures are often treated with dynamic hip screws (DHS) and cephalomedullary nailing (CMN).[6]

Basicervical femoral neck fracture (BFNF) is located between the femoral neck and intertrochanteric region and accounts for 1.8%–7.7% of all hip fractures. It is a biomechanically unstable fracture with a high clinical treatment failure rate.[5,7] To date, many clinical trials and biomechanical studies have attempted to identify an appropriate implant for application in BFNF.[8-10] Mousapour, et al.[11] reported that CCS fixation, which is often used for intracapsular fractures, is not effective for BFNF, and that arthroplasty is more effective than DHS for the initial treatment of displaced BFNF. However, in general, arthroplasty leads to increased bleeding and higher morbidity compared to osteosynthesis, and it is difficult to consider arthroplasty as an initial treatment particularly in young patients. Moreover, it is onerous to consider arthroplasty as the initial treatment for BFNF since avascular necrosis and non-union, which are major complications of intra-capsular fractures, have not been reported often in basal neck fractures.

Many studies have reported the treatment outcome of DHS and CMN, which are often used for extracapsular hip fractures, and the results have been controversial. Initially, sliding hip screws were reported to be rotationally unstable owing to their conical shape, and anti-rotational effects of additional cancellous screws were reported.[12] However, another study reported that additional screws with sliding hip screws did not influence fracture stability or clinical outcome.[5] It was subsequently reported that CMN is biomechanically stable and less invasive, and demonstrated clinically and radiographically favorable outcomes in BFNF.[13] However, recent reports also suggested that CMN is not appropriate for unstable BFNF.[14]

Owing to such conflicting reports, appropriate treatment for BFNF remains a controversial issue, and only one review article has been published on the topic.[9] However, the same review article did not involve meta-analysis and suggested that further research is needed without offering a clear directive regarding various implants. To our knowledge, this is the first meta-analysis to determine an appropriate implant for BFNF. This study aimed to comparatively analyze the clinical and radiographical outcomes of DHS and CMN, both of which are currently used for fixation of BFNF, by employing a meta-analysis and systematic review to determine the appropriate implant for BFNF.

MATERIALS AND METHODS

This study was performed in accordance with the guidelines of the Revised Assessment of Multiple Systematic Reviews and Preferred Reporting Items for Systematic Reviews and Meta-Analyses.[15,16] Although the present study involved human participants, ethical approval or informed consent from the participants was not required since all of the data were based on previously published studies that were analyzed anonymously without potential harm to the participants.

Literature search

In compliance with the referenced guidelines, MEDLINE, Embase, and the Cochrane Library were searched for studies that compared the treatment outcomes of using CMN and DHS for the fixation of BFNFs. Using an a priori search strategy, articles published up to January 9, 2021 were identified. The search terms included synonyms and related terms for CMN, DHS, and BFNF as follows: (“nail*” OR “nailing*”) AND (“DHS” OR “screw*” OR “fixed angle*”) AND (“Fracture*”) AND (“femur neck” OR “femoral neck” OR “basicervical” OR “cervicotrochanter*”). There were no restrictions on either language or publication year. After the initial electronic search, relevant articles and their bibliographies were also manually searched.

Study selection

Two board-certified orthopedic trauma surgeons independently selected the studies for full-text review from the titles and abstracts of the studies. The full article was reviewed if the abstract provided insufficient data to decide.

In this systematic review, the following inclusion criteria were used: 1) direct comparison of intramedullary nailing and extramedullary DHS fixation to treat BFNF; 2) population: patients diagnosed with BFNF; 3) intervention: intramedullary nailing; 4) control: extramedullary DHS fixation; and 5) outcomes: treatment outcomes including clinical and radiologic outcomes. We excluded the studies that 1) were not performed for CMN, such as ender nail; 2) included the non-traumatic fractures, such as pathologic fractures; 3) were performed for combined fractures, such as femoral shaft fractures; 4) were not original articles, including biomechanical or cadaveric studies, technical notes, letters to the editor, conference abstracts, expert opinions, review articles, meta-analyses, and case reports; 5) did not report results that would allow us to obtain or calculate comparative data; and 6) were duplicates from the same investigation group.

At each stage of the literature search, kappa values were calculated to determine inter-reviewer agreement for the study selection. Agreement between reviewers was correlated with kappa values a priori: κ=1 indicated “perfect” agreement; 1.0>κ≥0.8 indicated “almost perfect” agreement; 0.8>κ≥0.6 indicated “substantial” agreement; 0.6>κ≥ 0.4 indicated “moderate” agreement; 0.4>κ≥0.2 indicated “fair” agreement; and κ<0.2 indicated “slight” agreement.

Data extraction

To synthesize the qualitative data, information on the following variables was extracted using a standardized form: the study design, number of patients investigated, type of implant used, mean patient age, and follow-up period. The modality used for diagnosing BFNF and the type of lag device employed for CMN were also considered in the investigation.

In the pooled analysis, the following data were extracted from the included studies for both CMN and DHS groups: 1) fracture union time, 2) the rate of cut-out, and 3) the reoperation rate for any reason.

For data extraction, the same two board-certified orthopedic surgeons, who participated in the study selection, independently recorded the data from each enrolled study. Disagreements between the reviewers were resolved by discussion between the two investigators.

Methodological quality assessment

The methodological quality of the included studies was assessed using the Methodological Index for Nonrandomized Studies (MINORS),[17] which is a valid tool for assessing the quality of non-randomized studies. The maximum MINORS checklist score for comparative studies was 24. Two independent reviewers performed a quality assessment and resolved disagreements through discussion.

Data synthesis and statistical analyses

The main outcome of the present meta-analysis was the comparison of fracture union time, postoperative cut-out rate, and reoperation rate for any reason.

Dichotomous data were analyzed using the odds ratios (OR), while continuous data were analyzed using the standard mean differences with 95% confidence intervals (CI). Heterogeneity was assessed using the I^2 statistic, in which 25%, 50%, and 75% were considered low, moderate, and high heterogeneity, respectively. Forest plots were used to display the outcomes, pooled estimates of effects, and overall summary effect of each study. Statistical significance was set at $p<0.05$. All data were pooled using a random-effects model, which was recommended previously to avoid overestimation of the study results, particularly in the field of medicine.[18] We did not test for publication bias as it is typically recommended when at least 10 studies are included in the meta-analysis.[19] Statistical analyses were performed using the Review Manager (RevMan) software (version 5.3; Copenhagen, Denmark), Nordic Cochrane Center, Cochrane Collaboration 2014, and "Metafor" package in R (version 3.4.3; R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Study identification

The details of study identification and the selection process are summarized in Fig. 1. The initial electronic literature search yielded 713 articles. After removing 307 duplicates and adding the two additional papers identified through manual searching, 408 studies were screened; 395 studies were excluded after their titles and abstracts were reviewed, and an additional six studies were excluded after full-text review. Therefore, seven studies were eligible for data extraction and meta-analysis. The agreement on study selection between the reviewers at the title review was "substantial" (κ=0.726) and abstract review stages was "almost perfect" (κ=0.859). At the full-text review stage, the inter-observer agreement was perfect (κ=1.0).

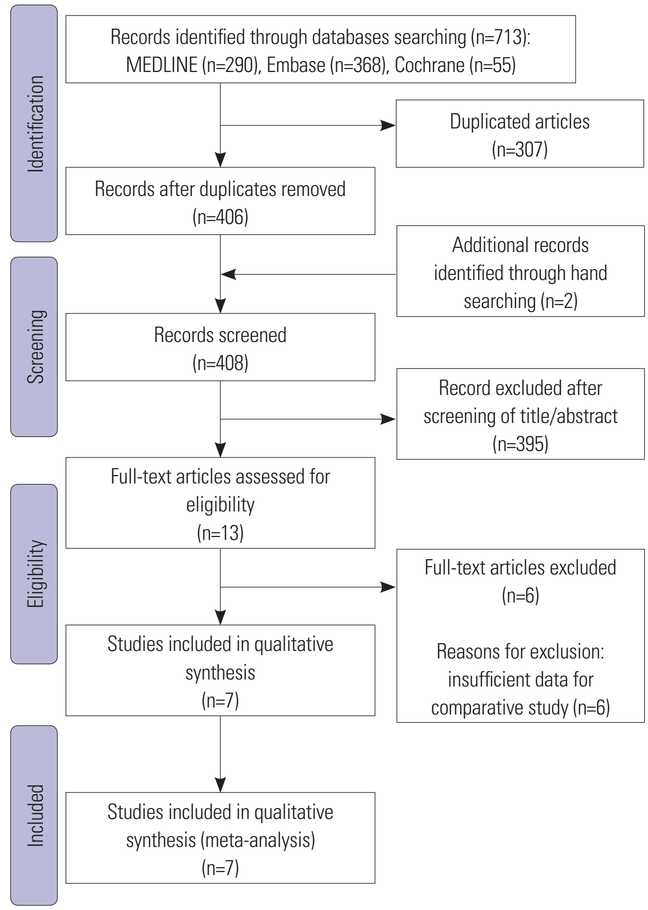

Fig. 1. Preferred Reporting Items for Systematic reviews and Meta-analyses (PRISMA) flow diagram for the identification and selection of studies included in the meta-analysis.

Study characteristics

Of the seven studies,[7,8,20-24] there were two randomized controlled trials (RCTs)[7,20] and the other five were retrospective cohort studies.[8,21-24]

In total, 353 patients with BFNF were included in the study. CMN was used when treating 206 of the patients (CMN group), whereas DHS was used when treating 147 patients (DHS group). For the CMN, Profin (TST, Istanbul, Turkey), Intertan (Smith & Nephew, Inc., Memphis, TN, USA), Gamma-3 nail (Stryker, Kiel, Germany), Zimmer natural nail (ZNN) (Zimmer, Warsaw, IN, USA), intertrochanteric/subtrochanteric (ITST) nail (Zimmer), and Proximal Femoral Nail Antirotation (PFNA) nail (DePuy Synthes, Solothurn, Switzerland) were used. The mean age of patients ranged from 47.5 years to 81.3 years. The mean follow-up period ranged from 1.0 year to 5.0 years. Two of the included studies[21,24] employed both simple radiographs and CT images to diagnose BFNFs, while the others used sim-

https://doi.org/10.3349/ymj.2022.63.8.744

ple radiographs alone. Further details on each included study are presented in Table 1.

Risk of bias assessment

The mean MINORS score for methodological quality assessment was 18.7/24 (range: 18–21) (Table 1). With regard to the eight main evaluation parameters, five studies 21-25 received a point deduction for their retrospective design. All seven studies[7,8,20-24] received a point deduction for the lack of double-blind evaluation of subject endpoints. One study 20 received a point deduction for loss to follow-up of up to 5% compared to the initial number of enrolled patients. All studies except one[7,8,21-24] received a point deduction in the study size calculation domain, as the sample size was not calculated prospectively in any of the studies. There were no point deductions in the other criteria domains.

The result of meta-analysis

Union time

Data on fracture union time following the use of CMN and DHS fixation techniques were extracted from three studies.[7,21,24] The range of fracture union time was 13.5–24.0 weeks and 13.9–22.0 weeks in the CMN and DHS groups, respectively. The pooled analysis revealed that the DHS group required a longer time to achieve fracture union compared to the CMN group (MD: -0.41; 95% CI: -0.70 to -0.12; p=0.006). The heterogeneity was considered low (I^2=0%), and the forest plot and details are shown in Fig. 2.

Cut-out rate of lag screw

Four studies,[8,20-22] included data on the incidence of lag screw cut-out rate in the CMN and DHS groups. The pooled analysis showed no statistically significant difference in the incidence of cut-out between the two groups (OR=0.54; 95% CI: 0.10 to 2.82; p=0.47). The heterogeneity was considered low (I^2=24%), and the forest plot and details are shown in Fig. 3.

Reoperation rate at any reasons

Four studies[8,21-23] included data on reoperation rate after the treatment of CMN and DHS groups for BFNF. The pooled analysis showed no statistically significant differences in the reoperation rate between the two groups (OR=0.65; 95% CI: 0.15 to 2.86; p=0.57). The heterogeneity was considered low (I^2= 19%), and the forest plot and details are shown in Fig. 4.

DISCUSSION

We performed clinical and radiographic comparisons of CMN and DHS, the most commonly used implants for BFNF. Despite DHS requiring statistically significant longer union time than CMN, both fixtures yielded similar clinical outcomes in BFNF and provided appropriate fixation with similar cut-out or reop-

Table 1. Study Design, Demographic Data, Study Characteristics, and MINORS Scores of Included Studies

Author (year)	Study design	No. of patients		Implant type		Mean age (yrs)	Mean f/u (yrs)	Method for Dx. BFNF	Types of lag device for CMN	MINORS score
		CMN	DHS	CMN	DHS					
Eceviz, et al. (2020)[20]	RCT	29	27	Profin	DHS	80.8	>1.0	N/A	Double screws	21
Jian, et al. (2020)[21]	RCS	18	7	PFNA Intertan	DHS	72.1	2.7	X-ray, CT	Blade, double screws	18
Kim, et al. (2020)[8]	RCS	67	39	Gamma-3, ZNN, ITST, PFNA, Intertan	DHS	76.4	2.2	X-ray	Blade, single screw, double screws	18
Lee, et al. (2018)[22]	RCS	40	29	PFNAII	DHS	81.3	2.6	X-ray	blade	18
Saarenpää, et al. (2002)[23]	RCS	4	10	Gamma-3	DHS	76.9	5.0	X-ray	Single screws	18
Sharma, et al. (2018)[7]	RCT	32	27	PFN	DHS	47.5	>2.0	X-ray	N/A	20
Zhang, et al. (2017)[24]	RCS	16	8	N/A	DHS	N/A	N/A	X-ray, CT	N/A	18

CMN, cephalomedullary nail; DHS, dynamic hip screw; BFNF, basicervical femoral neck fracture; MINORS, Methodological Index for Nonrandomized Studies; RCT, randomized controlled trial; RCS, retrospective cohort study; N/A, not available; PFNA, Proximal Femoral Nail Antirotation; ZNN, Zimmer natural nail; ITST, intertrochanteric/subtrochanteric; PFNAII, proximal femoral nail antiroataion II.

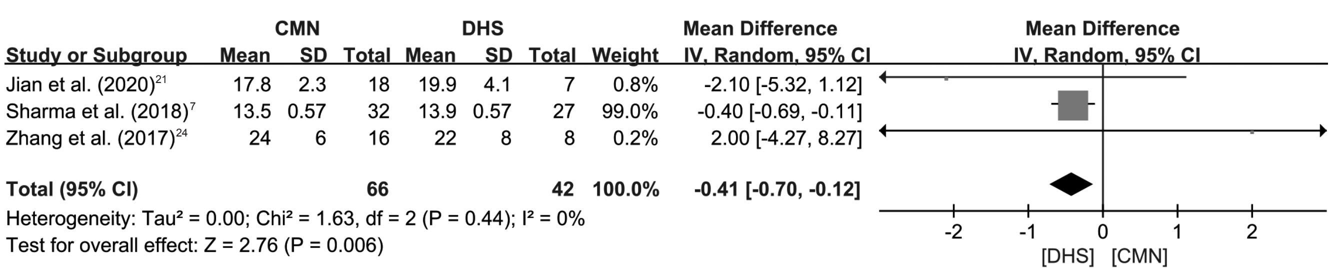

Fig. 2. Forest plot depicting the union time following basicervical femoral neck fracture between CMN and DHS fixation. CMN, cephalomedullary nail; DHS, dynamic hip screw; CI, confidence interval.

Study or Subgroup	CMN Events	CMN Total	DHS Events	DHS Total	Weight	Odds Ratio M-H, Random, 95% CI
Eceviz et al. (2020)[20]	0	29	1	27	20.6%	0.30 [0.01, 7.67]
Jian et al. (2020)[21]	1	18	0	7	19.9%	1.29 [0.05, 35.31]
Kim et al. (2020)[8]	3	67	0	39	23.4%	4.29 [0.22, 85.21]
Lee et al. (2018)[22]	1	40	5	29	36.1%	0.12 [0.01, 1.12]
Total (95% CI)		**154**		**102**	**100.0%**	**0.54 [0.10, 2.82]**
Total events	5		6			

Heterogeneity: Tau² = 0.69; Chi² = 3.96, df = 3 (P = 0.27); I² = 24%
Test for overall effect: Z = 0.73 (P = 0.47)

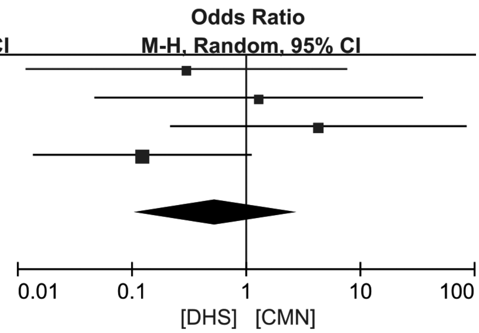

Fig. 3. Forest plot illustrating the cut-out rate following basicervical femoral neck fracture between CMN and DHS fixation. CMN, cephalomedullary nail; DHS, dynamic hip screw; CI, confidence interval.

Study or Subgroup	CMN Events	CMN Total	DHS Events	DHS Total	Weight	Odds Ratio M-H, Random, 95% CI
Jian et al. (2020)[21]	1	18	0	7	17.2%	1.29 [0.05, 35.31]
Kim et al. (2020)[8]	4	67	1	39	32.9%	2.41 [0.26, 22.39]
Lee et al. (2018)[22]	1	40	5	29	33.4%	0.12 [0.01, 1.12]
Saarenpää et al. (2002)[23]	0	4	1	10	16.5%	0.70 [0.02, 20.91]
Total (95% CI)		**129**		**85**	**100.0%**	**0.65 [0.15, 2.86]**
Total events	6		7			

Heterogeneity: Tau² = 0.43; Chi² = 3.69, df = 3 (P = 0.30); I² = 19%
Test for overall effect: Z = 0.56 (P = 0.57)

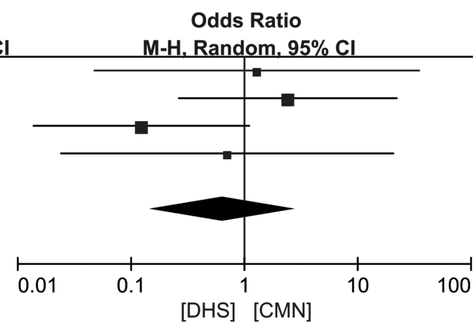

Fig. 4. Forest plot showing the reoperation rates for any reason following basicervical femoral neck fracture using CMN and DHS fixation. CMN, cephalomedullary nail; DHS, dynamic hip screw; CI, confidence interval.

eration rates, which indicate failure of the fixture.

BFNF is a fracture located at the anatomic transition between the femoral neck and the intertrochanteric region, and it has been treated similarly as intertrochanteric fractures.[25] However, in BFNF, there is no muscular insertion at the proximal fragment, and there is less cancellous interdigitation. Moreover, BFNF has a greater fracture angle as well as greater force and moment transferred through hardware compared to intertrochanteric fractures. Therefore, it can be seen as a more unstable fracture than intertrochanteric fracture.[9,26] For this reason, DHS was preferred over multiple screws in the past, and derotational screw with DHS was also preferred due to its rotational stability. Over time, the use of rigid intramedullary nails has increased.[8,22]

The longer union time in DHS patients than in CMN patients may be attributed to the fixation achieved through DHS. DHS, which is an extramedullary fixation, involves a longer lever arm than CMN. Therefore, DHS may not appropriately react to a shear force applied to the proximal fragment, and has a weaker buttress effect when compared to CMN. For this reason, more time is required until tolerable weight bearing is possible with DHS.[7,22]

Although fixation failure did not show any statistically significant difference in the present study, many studies have shown that CMN has a smaller bending moment on the implant, preventing further collapse of fracture site and causing less bone loss, compared to DHS.[27,28] CMN is already considered the treatment of choice in unstable intertrochanteric fractures, with low failure and complication rates. As a result, patients may initiate early post-operative rehabilitation.[29] Moreover, CMN is less invasive, leads to less bleeding, and involves a shorter operative time compared to DHS. However, Watson, et al.[14] reported a high failure rate of CMN in BFNF. In BFNF, the proximal fracture stump is narrow, and the distal stump is wide. Here, the nail inserts into the tip of the greater trochanter and is located immediately lateral to the fracture site. With this, the superior and inferior cortices of the proximal fragment encountered the nail and serve as buttresses. However, if the starting point is inserted medial to the tip of the greater trochanter to avoid varus malreduction, the superior cortex widens through reaming. This causes collapse in an asymmetrical direction to the intact inferior cortex, leading to malalignment and screw cut-out. Therefore, the entry point should not be medial to the tip of the greater trochanter in BFNF. Yoo, et al.[9] also reported that the failure mechanism of CMN involves varus or excessive sliding of the lag screw. The authors attributed this to the oval shape of the section of the basicervical femoral neck. Moreover, as the distal fragment does not rotate easily, the narrow proximal fragment is impacted easily against the wide distal fragment.

DHS also has favorable clinical and radiographical outcomes in BFNF. Particularly, Johnson, et al.[30] constructed a model of BFNF using 30 cadaveric femurs, and performed dynamic compression testing and cycles to failure mechanical testing of CMN and DHS. According to the test results, the authors concluded that one implant is not necessarily superior to the other. With

https://doi.org/10.3349/ymj.2022.63.8.744

the recent development of side plates, which are fixed through blades rather than lag screws, femoral head purchasing, compression against osteoporotic bone, and angular and rotational stability have been improved.[31] Moreover, considering the conversion to total hip arthroplasty after fixation failure, DHS results in less bleeding, shorter operative time, and simpler operation compared to CMN.

In all seven studies comparing CMN and DHS, the rates of complications, including infection, cut-out, osteonecrosis, and excessive sliding, were very low, and there was no significant difference between the implants. The union rate also did not differ between the two implants. This is comparable to the propensity-matched study by Warren, et al.[32] of over 17000 intertrochanteric and basicervical hip fractures, although the said study was not included in the present meta-analysis as its data were not appropriate for synthetic study. In their study, CMN and DHS did not differ in terms of major complications (p=0.117), and there was no significant difference in terms of readmission (p=0.588), reoperation (p=0.449), and union rate (p=1.000). In other words, both implants exhibited favorable clinical and radiographical outcomes in BFNF.

The current study had several limitations. First, the number of included studies was relatively small. Even after a systematic search with no restrictions on language and publication year, we were only able to identify seven suitable studies for quantitative synthesis. Nevertheless, BFNF is not a common fracture and only accounts for 1.8% of all proximal femoral fractures.[10] Therefore, it is difficult to conduct large-scale original studies, and meta-analysis is appropriate for the generation of a higher level of evidence in studies for which large cohorts are not feasible. Herein, we conducted a double-arm meta-analysis to include the studies that directly compared the use of CMN to DHS for treating BFNFs. In the future, conducting a network meta-analysis will be more appropriate to compare the outcomes of using not only CMN and DHS, but also arthroplasties for managing BFNFs. Second, except for two studies, five of the included studies were retrospective in nature. Pooling results based on predominantly retrospective studies can lead to an overestimation of outcomes. However, two RCTs also reported that the outcomes of the two implants were comparable. Third, since BFNF is located at the anatomical transition between the femoral neck and intertrochanteric regions, the anatomical definition may differ depending on the studies. However, the studies all described extracapsular, two-part fractures. Moreover, BFNF is defined in the studies as those that are medial to the intertrochanteric fracture line, those that do not involve the lesser trochanter, and those that are lateral to classic transcervical fractures. Considering this, we believed that this could contribute to meaningful bias in the interpretation of the results of the current meta-analysis. Last, we could not evaluate the possible bias from variable qualities of fracture reduction, such as extra/intramedullary reduction or tip-apex distance following surgery. However, this is inevitable when performing a synthetic study, and reduction quality did not differ between CMN and DHS in the studies included in the present review. Therefore, this limitation will not significantly contribute to bias.

In conclusion, BFNFs are highly unstable, even more so than intertrochanteric femoral fractures, with high failure and reoperation rates associated with the fixation techniques. However, stable fixation with CMN and DHS produces clinically and radiographically comparable outcomes; therefore, the implant can be selected according to the surgeon's preference, experience, and technical operating skills.

AUTHOR CONTRIBUTIONS

Conceptualization: Yong-Cheol Yoon. Data curation: Yong-Cheol Yoon and Chul-Ho Kim. Formal analysis: Chul-Ho Kim. Funding acquisition: Hyung Keun Song. Investigation: Yong-Cheol Yoon and Chul-Ho Kim. Methodology: Chul-Ho Kim. Project administration: Yong Chan Kim. Resources: Yong-Cheol Yoon and Chul-Ho Kim. Software: Chul-Ho Kim. Supervision: Chul-Ho Kim and Yong-Cheol Yoon. Validation: Yong Chan Kim and Hyung Keun Song. Visualization: Chul-Ho Kim. Writing—original draft: Yong-Cheol Yoon and Chul-Ho Kim. Writing—review & editing: Yong-Cheol Yoon and Chul-Ho Kim. Approval of final manuscript: all authors.

ORCID iDs

Yong-Cheol Yoon https://orcid.org/0000-0003-4137-0764
Chul-Ho Kim https://orcid.org/0000-0001-9233-5358
Yong Chan Kim https://orcid.org/0000-0002-0577-9098
Hyung Keun Song https://orcid.org/0000-0001-5486-2560

REFERENCES

1. Cooper C, Campion G, Melton LJ 3rd. Hip fractures in the elderly: a world-wide projection. Osteoporos Int 1992;2:285-9.
2. Sambrook P, Cooper C. Osteoporosis. Lancet 2006;367:2010-8.
3. Cullen MW, Gullerud RE, Larson DR, Melton LJ 3rd, Huddleston JM. Impact of heart failure on hip fracture outcomes: a population-based study. J Hosp Med 2011;6:507-12.
4. Antapur P, Mahomed N, Gandhi R. Fractures in the elderly: when is hip replacement a necessity? Clin Interv Aging 2011;6:1-7.
5. Su BW, Heyworth BE, Protopsaltis TS, Lipton CB, Sinicropi SM, Chapman CB, et al. Basicervical versus intertrochanteric fractures: an analysis of radiographic and functional outcomes. Orthopedics 2006;29:919-25.
6. Panteli M, Rodham P, Giannoudis PV. Biomechanical rationale for implant choices in femoral neck fracture fixation in the non-elderly. Injury 2015;46:445-52.
7. Sharma A, Sethi A, Sharma S. Comparative analysis of treatment of basicervical femur fractures in young adults with CCS, DHS, and PFN. Rev Bras Ortop 2018;53:783-7.
8. Kim JT, Ha YC, Park CH, Yoo JI, Kim TY. Single screw type of lag screw results higher reoperation rate in the osteosynthesis of basicervical hip fracture. J Orthop Sci 2020;25:152-5.
9. Yoo JI, Cha Y, Kwak J, Kim HY, Choy WS. Review on basicervical femoral neck fracture: definition, treatments, and failures. Hip Pelvis 2020;32:170-81.
10. Chen CY, Chiu FY, Chen CM, Huang CK, Chen WM, Chen TH. Surgical treatment of basicervical fractures of femur--a prospective evaluation of 269 patients. J Trauma 2008;64:427-9.

11. Mousapour A, Mardanpour K, Hojabrian A, Saeb M, Khabiri SS, Safari-Faramani R, et al. A comparison of bipolar hemiarthroplasty versus dynamic hip screw fixation of basicervical femoral neck fractures. J Orthop Spine Trauma 2019;5:25-8.
12. Kuokkanen HO. Treatment options for basicervical fractures of the femoral neck. A clinical follow-up. Acta Orthop Belg 1991;57:162-8.
13. Hu SJ, Yu GR, Zhang SM. Surgical treatment of basicervical intertrochanteric fractures of the proximal femur with cephalomeduallary hip nails. Orthop Surg 2013;5:124-9.
14. Watson ST, Schaller TM, Tanner SL, Adams JD, Jeray KJ. Outcomes of low-energy basicervical proximal femoral fractures treated with cephalomedullary fixation. J Bone Joint Surg Am 2016;98:1097-102.
15. Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. Syst Rev 2015;4:1.
16. Shea BJ, Grimshaw JM, Wells GA, Boers M, Andersson N, Hamel C, et al. Development of AMSTAR: a measurement tool to assess the methodological quality of systematic reviews. BMC Med Res Methodol 2007;7:10.
17. 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;73:712-6.
18. Schmidt FL, Oh IS, Hayes TL. Fixed- versus random-effects models in meta-analysis: model properties and an empirical comparison of differences in results. Br J Math Stat Psychol 2009;62(Pt 1):97-128.
19. Higgins JP, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, et al. Cochrane handbook for systematic reviews of interventions. 2nd ed. Chichester: John Wiley & Sons; 2019.
20. Eceviz E, Çevik HB, Bulut G. Comparison of intramedullary and extramedullary fixation of basicervical fractures of the femur in the elderly: a prospective randomized study. Med Bull Haseki 2020;58:169-75.
21. Jian Z, Lv T, Ao R, Jiang X, Zhou J, Yu B. Comparison of clinical outcomes between cephalomedullary nails and dynamic hip screws for basicervical proximal femoral fractures. Research Square [Preprint]. 2020 [accessed 2022 March 1]. Available at: https://doi.org/10.21203/rs.3.rs-37367/v1.
22. Lee YK, Yoon BH, Hwang JS, Cha YH, Kim KC, Koo KH. Risk factors of fixation failure in basicervical femoral neck fracture: which device is optimal for fixation? Injury 2018;49:691-6.
23. Saarenpää I, Partanen J, Jalovaara P. Basicervical fracture--a rare type of hip fracture. Arch Orthop Trauma Surg 2002;122:69-72.
24. Zhang TC, Zhang ZS, Zhou F, Tian Y, Ji HQ, Guo Y, et al. Diagnosis and treatment for the basicervical fractures of the trochanteric region. Beijing Da Xue Xue Bao Yi Xue Ban 2017;49:246-51.
25. Kweon SH, Lee SH, Kook SH, Choi YC. Outcomes of cephalomedullary nailing in basicervical fracture. Hip Pelvis 2017;29:270-6.
26. Massoud EI. Fixation of basicervical and related fractures. Int Orthop 2010;34:577-82.
27. Guo J, Dong W, Jin L, Yin Y, Zhang R, Hou Z, et al. Treatment of basicervical femoral neck fractures with proximal femoral nail antirotation. J Int Med Res 2019;47:4333-43.
28. Okano I, Sawada T, Kushima N, Tachibana T, Inagaki K. Treatment with helical blade cephalomedullary nail for two-part basicervical proximal femoral fracture in elderly patients: a retrospective observational study. Geriatr Orthop Surg Rehabil 2017;8:244-51.
29. Huang SG, Chen B, Zhang Y, Nie FF, Ju L, Li M, et al. Comparison of the clinical effectiveness of PFNA, PFLCP, and DHS in treatment of unstable intertrochanteric femoral fracture. Am J Ther 2017; 24: e659-66.
30. Johnson J, Deren M, Chambers A, Cassidy D, Koruprolu S, Born C. Biomechanical analysis of fixation devices for basicervical femoral neck fractures. J Am Acad Orthop Surg 2019;27:e41-8.
31. Xiong WF, Du SC, Chang SM. Choosing an optimal implant fixation for basicervical femoral neck fractures. Injury 2018;49:1238-9.
32. Warren JA, Sundaram K, Hampton R, McLaughlin J, Patterson B, Higuera CA, et al. Cephalomedullary nailing versus sliding hip screws for Intertrochanteric and basicervical hip fractures: a propensity-matched study of short-term outcomes in over 17,000 patients. Eur J Orthop Surg Traumatol 2020;30:243-50.

https://doi.org/10.3349/ymj.2022.63.8.744