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Cemented versus uncemented hemiarthroplasty for femoral neck fractures in elderly patients

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ABSTRACT

Background: Controversy still exists regarding using cemented or uncemented hemiarthroplasty for femoral neck fractures in elderly patients. The aim of this study is to compare the effectiveness and safety of the two surgical techniques in femoral neck fracture patients over 60 years old.
Methods: We searched PUBMED from inception to December 2012 for relevant randomized controlled trials (RCTs). Outcomes of interest include postoperative hip function, residue pain, complication rates, mortality, reoperation rate, operation time and intraoperative blood loss. Odds ratios (OR) and weighted mean differences (WMD) from each trial were pooled using random-effects model or fixed-effects model given on the heterogeneity of the included studies.
Results: Our control trial involved 132 patients (132 hips) who were eligible for the study. Our results demonstrate that cemented hemiarthroplasty is associated with better postoperative hip function (OR=0.48, 95% CI, 0.31–0.76; p=0.002), lower residual pain (OR=0.43, 95%CI, 0.29–0.64; p<0.0001), less implant-related complications (OR=0.15, 95%CI, 0.09–0.26; p<0.00001) and longer operation time (WMD=7.43 min, 95% CI, 5.37–9.49 min; p<0.00001). No significant difference was observed between the two groups in mortality, cardiovascular and cerebrovascular complications, local complications, general complications, reoperation rate and intraoperative blood loss.
Conclusions: Compared with uncemented hemiarthroplasty, the existing evidence indicates that cemented hemiarthroplasty can achieve better hip function, lower residual pain and less implant-related complications with no increased risk of mortality, cardiovascular and cerebrovascular complications, general complications, local complications and reoperation rate in treating elderly patients with femoral neck fractures.

Keywords: Femoral neck fractures, Cemented hemiarthoplasty, Uncemented hemiarthoplasty, Bipolar prosthesis

INTRODUCTION

Femoral neck fracture is a most common injury which can lead to increased postoperative morbidity and mortality in senior patients. Hemiarthroplasty, as an effective treatment, contributes to early ambulation and good functional recovery as mentioned by Bhandari et al and Crossman et al.[1,2] However, there has been persistent controversy over whether cemented hemiarthroplasty (CH) or uncemented hemiarthroplasty (UCH) is preferable for the patient population. CH may bring low periprosthetic fractures and prosthetic loosening whereas it may lead to embolism and decreased cardiac output with the insertion of bone cement.[3-6] However, there is a higher rate of postoperative prosthesis loosening for UCH while it may achieve shorter operation time and less intraoperative blood loss.

Several systematic reviews have been published in recent years trying to compare CH and UCH. Khan et al performed a review involving 18 prospective and retrospective studies and claimed that in spite of its longer operation time and more intraoperative blood loss, CH possesses such advantages as better mobility, lower revision rate and less thigh pain without increasing postoperative complication and mortality rates at 1 month.[7] A meta-analysis involving 7 RCTs and 1 quasi-RCT revealed that CH was associated with significantly reduced pain at 3 months and during the next 1–2 years, and there was no significant difference between CH and UCH in terms of complications, reoperation rate, perioperative and postoperative mortality. The meta-analysis by Luo et al, which enrolled 8 RCTs (2 were indeed non-RCTs), demonstrated that there was no significant difference between CH and UCH regarding the mortality, reoperation rate and postoperative complications, while CH can reduce the risk of residual pain (RR=0.69, 95% CI 0.53–0.90; p=0.007; fixed-effects model) and achieve better functional recovery (a descriptive analysis).[8] Azegami et al performed a meta-analysis which pooled 8 RCTs and quasi-RCTs (the methodological quality of 2 trials ≤4 scores and the maximum quality score is 12 points) and reported that CH achieved better functional outcome and less residual pain.[9] These studies, though compared many variables of the two techniques using meta-analysis, still need to be improved in three aspects. Firstly, predictable bias from quasi-RCTs or non-RCTs exists in all these studies. Secondly, complications of CH and UCH have not been stratified in the previous systematic reviews before comparison. Lastly, 2 latest RCTs, both of which compared the two techniques in treating elderly patients with femoral neck fractures and were published in 2012 have not been enrolled in any meta-analysis. We are therefore performing this study to compare the effectiveness and safety of CH and UCH in treating femoral neck fractures in senior patients, in order to provide more accurate evidences for surgeons in making a clinical decision.

The specific questions that our study aims to answer include: (A) Does UH achieves better postoperative hip function and pain relief? (B) Is there any difference existing in the stratified postoperative complication rates between CH and UCH? (C) Do the mortality rates at different postoperative time points differ significantly between the two groups? (D) Which technique brings higher reoperation rate? (E) Is the operation time for CH significantly longer than that of UCH? (F) Is there any difference existing in the intraoperative blood loss between CH and UCH?

METHODS

A comprehensive search of unrestricted language literatures of all studies comparing CH with UCH was conducted through the online databases of PUBMED. The following medical subject headings were searched: arthroplasty, hip fractures, and femoral neck fracture. Hand-search of relevant trials, reviews and related articles were also performed.

Duration of study

Study was conducted from January 2016 – December 2018.

Selection criteria

All elderly patients who underwent CH and UCH for femoral neck fractures were eligible. The participants should be over 60 years old and underwent primary hemiarthroplasty for unilateral femoral neck fractures. Only bipolar prosthesis was used.

Inclusion criteria

Inclusion criteria were patients above 60 years of age; unilateral femoral neck fracture; primary hemiarthroplasty.

Exclusion criteria

Exclusion criteria were patients less than 60 years of age; IT and Subtrochanteric fractures; revision surgery.

Outcomes of interest

The primary outcomes were analysed using Modified Harris hip score at 1 year, including postoperative hip function, residual pain, complications rates and mortality.[10] Postoperative hip function outcomes at 1 year were analysed. We stratified complications into four categories. The first category includes such implanted-related complications as intraoperative and postoperative periprosthetic fractures, prosthesis loosening and dislocation. The second category includes cardiovascular and cerebrovascular complications such as intraoperative cardiac arrest, myocardial infarction, acute cardiac arrhythmia, intraoperative severe blood pressure reduction during preparation of femoral canal, cerebrovascular accidents, pulmonary embolism and deep venous thrombosis. The third category focuses on local complications including superficial or deep wound infection, wound hematoma, incision rupture and ectopic calcification. The last category includes general complications such as pneumonia, urinary tract infection, bedsore, gastrointestinal bleed, acute renal failure, etc. Mortality involves perioperative mortality, mortality at postoperative 1 month, 3 months and 1 year. The secondary outcomes consist of reoperation rate, operation time and intraoperative blood loss.

Statistical analysis

For each included study, odds ratio (OR) and 95% confidence intervals (CI) were calculated for dichotomous outcomes, while weighted mean differences

(WMD) and 95% CI were calculated for continuous outcomes. Statistical heterogeneity was assessed using the I^2 value and chi-squared test. A $p>0.1$ and an I^2 value ≤50% were considered as no statistical heterogeneity and an application of fixed-effects model was used to estimate the overall summary effect sizes. Otherwise, random-effects model was adopted and a subgroup analysis or sensitivity analysis would be carried out. All analyses were completed with Review Manager Software (RevMan 5.2) and $p<0.05$ was considered as significant.

RESULTS

A total of 132 patients involving 132 hips were included. 105 patients were considered for this study as they were regular for follow up. The follow-up period was 12 months and parameters were assessed based on Harris hip score.

Post operative HIP function

The hip function was analysed based on the Harris hip scoring system in which 90-100 was considered excellent, 80-89 being good, 70-79 being fair and less than 70 being poor.

Average Harris hip score was 91 for cemented and 89 for uncemented.

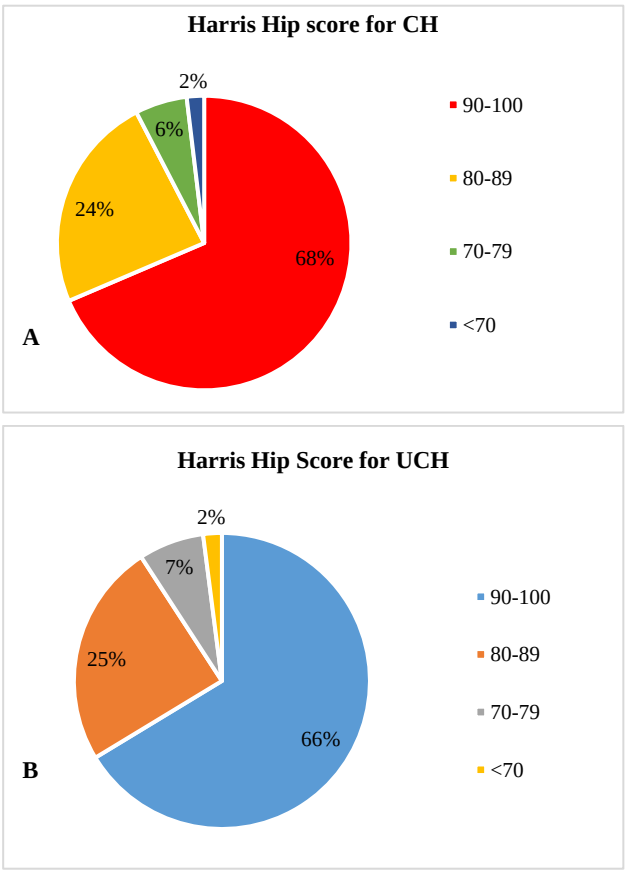

Figure 1 (A and B): Harris hip score CH vs UCH.

Operation time

A shorter operation time was observed for UCH compared to CH. UCH showed an average operation time of 1 hour 15 mins while CH showed an average of 1 hour 30 mins.

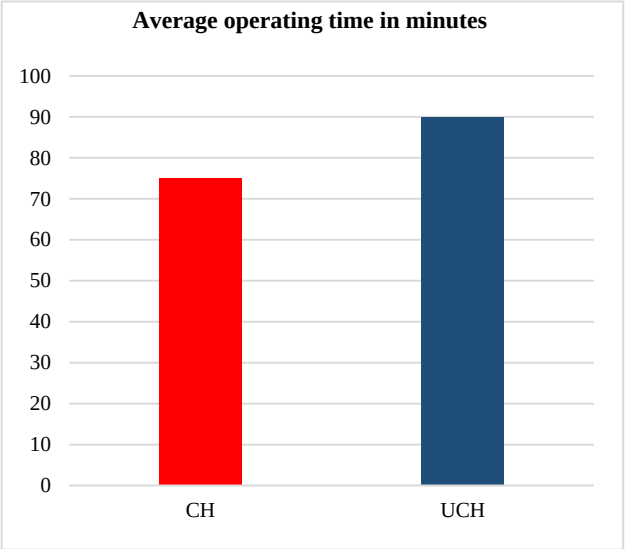

Figure 2: Average operating time.

Intraoperative blood loss

UCH showed less intraoperative blood loss while CH showed more.

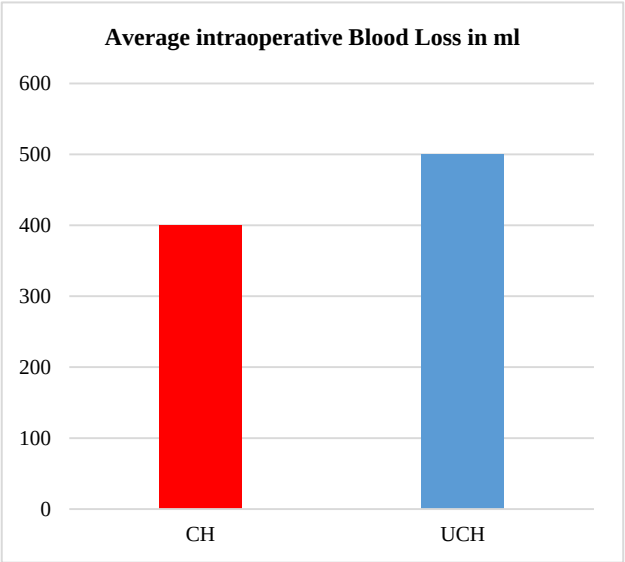

Figure 3: Intraoperative blood loss.

Complications

Odds ratio (OR) of implanted-related complications rates was 0.15, (95% CI, 0.09–0.26; $p<0.00001$) indicating that implanted-related complications rates in CH group were

lower than that in UCH group. However, there was no significant difference between the two groups in cardiovascular and cerebrovascular complications (OR=1.30, 95% CI, 0.72–2.36; p=0.38), local complications (OR=1.29, 95% CI, 0.78–2.15; p=0.32) and general complications (OR=0.68, 95% CI, 0.45–1.03; p=0.07).

Rate of infection was 2% (1/50) in the UCH group while 3.6% (2/55) in the CH group. The patient in UCH group had a deep seated infection which was managed by open drainage and thorough wash and IV antibiotics following which the infection settled. The two patients in CH group had superficial infections which were managed by incision drainage and IV antibiotics following which they recovered.

2 patients from the UCH group had loosening of implant while 1 patient from CH showed loosening. One patient from UCH group sustained periprosthetic greater trochanter fracture which was managed by open reduction and TBW.

One patient from the CH group developed sudden fall in blood pressure following cement insertion and was admitted to the ICU post op. Patient was managed conservatively with life saving measures and recovered. Patient was shifted to ward and post op mobilisation protocols initiated after 3 days.

DISCUSSION

With the trend of global aging, femoral neck fracture has become an increasingly serious problem for senior patients. Hemiarthroplasty, as an effective treatment, can help resume the walking ability as soon as possible, thereby reduce the risk of respiratory infection and urinary tract infection. However, there has been controversy regarding the use of cement for a long time. Some surgeons prefer to apply the UCH technique since it can reduce operation time, intraoperative blood loss and perioperative cardiovascular complications, while others believe that the CH technique can achieve better postoperative hip function recovery and less prosthesis loosening. We therefore performed this study regarding the comparison of CH and UCH techniques for femoral neck fractures.

In this study, we pooled the number of patients requiring assistance with ambulation from each trial, which was the only common parameter from the enrolled trials in assessing the postoperative hip function. Although we could not demonstrate a statistically significant difference between the 2 groups at 2 months, there was a trend towards better postoperative functional recovery for CH at this time point. The postoperative hip function at 1 year was better in CH group than that in UCH group, indicating that with the time passing after the operation, CH technique can bring better joint function recovery, which is consistent with previous studies.[7,9–12] In a retrospective study involving 447 patients with 451 displaced fractures of femoral neck treated by Bateman bipolar hemiarthroplasty, Lo et al found that the cemented prostheses brought better functional results in the early stage.[13] Khan's study using validated scoring systems for pain and functional ability assessment demonstrated that there was significant deterioration in pain (p=0.003), walking ability (p=0.002), and daily activities (p=0.009) in the UCH group during the follow-up of 32–36 months.[14] Other researchers suggested that there was no clinically or statistically significant difference in the postoperative hip function recovery.[15-16] In spite of an obvious tendency for CH in postoperative function recovery, it was difficult to pool and compare other parameters due to the inconsistency of outcome parameters applied. Further researches with large samples and standardized hip function scoring systems are warranted to confirm these findings and elucidate the potential advantages of CH in postoperative hip function recovery.

With regards to the residual pain, 6 included studies reported related results and the pooled results showed that CH have less residual pain compared with UCH with high heterogeneity (p=0.04, I^2=58%). It worth noting that one enrolled trial adopted hydroxylapatite coated implant while other four trials used non-hydroxylapatite coated prostheses including Austin Moore prostheses and Alloclassic implants.[17] As an earlier randomized trial reported, better pain relief was achieved with uncemented hydroxylapatite coated implant than with the Austin Moore prosthesis.[18] We therefore speculated that the high heterogeneity in our analysis result from the different types of uncemented prostheses used among the trials we enrolled. In order to further explore the source of heterogeneity, a further sensitivity analysis was performed with this trial being excluded and the pooled results with no heterogeneity (p=0.48, I^2=0%) showed that CH was associated with less residual pain, which was consistent with our previous results.[17] Several non-RCT studies also support our findings, reporting that CH led to less residual pain than UCH with significant difference.[14,18,19]

We also found significantly higher implant-related complications associated with CH than UCH. Our result was in agreement with a previous study which indicated that UCH led to more intraoperative and postoperative periprosthetic fractures, prosthesis loosening and dislocation.[20] Therefore surgeons should pay more attention to these possible complications prior to surgery. However, no significant difference was found between the two groups in cardiovascular and cerebrovascular complications, although previous studies revealed that the cement insertion might increase the danger of transient hypotension and hypoxaemia, pulmonary embolism, and cardiovascular system accidents.[3-6,21–22] Furthermore, there was no significant difference between the two groups in local complications and general complications, indicating that cement play little, if not none, role in local

and general complications. Interestingly, a recent large scale retrospective study comparing CH with UCH involving 60,848 patients showed that cementless implants were related with significantly higher rates of myocardial infarction (2.86% versus 2.46%, OR=1.17, 95%CI, 1.07–1.28) and lower respiratory tract infection (9.21% versus 7.26%, OR=1.15, 95% (1.09–1.22), p<0.001) within 30 days compared with cemented implants.[20] Certainly, high quality evidences with well-designed RCTs are still required.

Previous studies showed that the cement may play an important role in mortality increase due to its possible risk of inducing cerebrovascular complications and cardiovascular events.[21,22] Nevertheless, our study found no significant difference between CH group and UCH group in perioperative mortality and mortality at postoperative 1 month, 3 months, and 1 year, indicating that the use of cement does not increase the aforementioned risks. Only one study reported that one patient experienced severe reduction of blood pressure during the cementing procedure and died within 24 hours of a myocardial infarction, and another patient developed intraoperative cardiac arrest during wound closure.[17] Other studies demonstrated that the mortality rate at 12 months of follow-up was similar between the two groups.[16,23] Besides, old age, deteriorated preoperative cardiopulmonary function and physical reserve have been regarded as risk factors recently.[22,24]

In addition, there was a tendency of higher reoperation rate in UCH group although no significant difference was found between the two groups in the study. The aforementioned national retrospective study involving 60,848 matched patients supported our findings by demonstrating that revision rates in UCH group were higher than that in CH group at 18 months (1.66% versus 0.67%, OR=2.90, 95%CI 2.50–3.37, p<0.001) and 4 years (2.56% versus 1.39%, OR=2.22, 95%CI 1.84–2.70, p<0.001).[22]

Our study demonstrated that CH was related with significantly prolonged operation time, which was consistent with the studies by Khan and Azegami.[7,9] It may result from the process of cement insertion and the waiting time for the solidification of cement. As for intraoperative blood loss, the pooled results with high heterogeneity (p=0.01, I^2=73%) showed that there was no significant difference between CH group and UCH group. We speculated that the inconsistency of types of prostheses used in these studies may be the possible explanation of the high heterogeneity. As we discussed above, one trial adopted hydroxylapatite coated implant while other three trials used non-hydroxylapatite coated prostheses, which was regarded as the source of heterogeneity.[17] In order to decrease the heterogeneity to an acceptable level, a further sensitivity analysis was conducted with this trial being excluded and the pooled results with low heterogeneity (p=0.31, I^2=14%) were in agreement with our previous analysis.[17]

The grading of recommendations assessment, development and evaluation (GRADE) recommended by The Cochrane collaboration provides a system for rating quality of evidence and strength of recommendations that is explicit, comprehensive, transparent, and pragmatic and is increasingly being adopted by organizations worldwide. In this study, we adopted the GRADE system to evaluate our results. The quality of evidence of most outcomes in our study was high. However, evidence strength for postoperative hip function, residual pain, and intraoperative blood loss were graded as low due to following reasons:

- The hip sample size was relatively small in postoperative hip function, residual pain, and intraoperative blood loss analysis.
- Criterions assessing the postoperative hip function in different trials may be different.
- Criterions assessing residual pain in different trials may be different. For example, pain on flexion to 45° was adopted by a study whereas another trial adopted free of pain medication as the criterion.
- There is high heterogeneity among studies included in the analysis of residual pain (p=0.04, I^2=58%) and intraoperative blood loss (p=0.01, I^2=73%).

Compared with previous systematic reviews, there are several improvements in this study. Firstly, this study adopted more strict inclusion criteria. Secondly, two strategies were used to assess the methodological quality of the included studies. All the included studies were of highly qualified methodology according to the quality assessment system, which contributes to the strength of conclusions drawn from the study. Thirdly, complications were further stratified into implanted-related complications, cardiovascular and cerebrovascular complications, local complications and general complication, reducing the potential bias risk from pooling all kinds of complications. Fourthly, we pooled the data of one comparable parameter regarding postoperative hip function to reduce the bias of the descriptive analysis. Lastly, GRADE system was adopted for the assessment of the quality of evidences so as to better guide the clinical practice better.

Despite these advantages, some limitations are still recognized. Firstly, the number of trials included in the study is still relatively small and it is therefore difficult for us to conduct funnel plots to assess the publication bias. Secondly, various types of prostheses involved in this study may bring related bias. Thirdly, since the outcome parameters in different trials were different, it is impossible to pool all kinds of parameters regarding hip function. Instead, only one parameter was analysed in our study. Lastly, only short and middle term follow-up data

are available and long term follow-up results still need disclosing in the future.

CONCLUSION

Our study compared cemented and uncemented hemiarthroplasty for femoral neck fractures in elderly patients. Our results suggested that CH technique, compared with UCH, is related with better hip function recovery, lower residual pain, less implant-related complications. There was no significant overall difference in mortality rate, cardiovascular and cerebrovascular complications, general complications, local complications and reoperation rate. Multicentre randomized controlled trials with large samples are still needed in the future to verify our results.

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Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

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