



Systematic Review and Meta-analysis

Quadratus femoris muscle pedicle bone flap transplantation in the treatment of femoral neck fracture for Chinese young and middle-aged patients: A systematic review and meta-analysis

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ABSTRACT

Purpose: To compare the efficacy of quadratus femoris muscle pedicle bone flap transplantation combined with hollow compression screw fixation versus AO hollow compression screw fixation in the treatment of femoral neck fracture for Chinese young and middle-aged patients.

Methods: Case-controlled studies (CCTs) were used to compare the two operative methods in the treatment of femoral neck fractures. Data were retrieved from the Cochrane Library, Pubmed Database, CNKI, Chinese Biomedical Database.

Wanfang Data published during the period of January 2005 to December 2014. Methodological quality of the trials was critically assessed, and relevant data were extracted. Statistical Software Revman 5.0 was used for data-analysis.

Results: Eight articles were included in the meta-analysis. The results showed that there was statistical significance in the rate of fracture healing [OR = 5.43, 95% CI (2.89, 10.20), $p < 0.05$], the rate of good function of hip joint [OR = 5.12, 95% CI (3.21, 8.17), $p < 0.05$], the rate of femoral head necrosis [OR = 4.21, 95% CI (2.02, 8.76), $p < 0.05$], the time of fracture healing [WMD = -46.85, 95% CI (-65.13, -28.56), $p < 0.05$] between the two groups.

Conclusions: For the treatment of femoral neck fractures, the transplantation of quadratus femoris muscle pedicle bone flap combined with hollow compression screw fixation is superior to the AO hollow compression screw fixation in terms of the rate; of fracture healing, the rate of good function of hip joint, the rate of femoral head; necrosis and the time of fracture healing.

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Introduction

The management of femoral neck fractures especially the displaced ones in young adults is one of the most challenging tasks for orthopedic surgeons.^{1–3} Femoral neck fractures are relatively rare in young patients which often result from high-energy trauma.^{4,5} This kind of fracture is more prone to nonunion and femoral head necrosis because of its vertical fracture line in the collum femoris.^{6,7} The main complication of femoral neck fracture in young adults is

avascular necrosis, with the incidence of 15% (range 0–67%).⁸ Accurate reduction and firm fixation are vital for optimal results. However, owing to the breakdown of blood supply because of great violence, meronecrobiosis and collapse of the femoral head are commonly seen clinically.⁹

Judet et al¹⁰ described a successful case by using quadrates femoris muscle pedicle bone graft combining with screw fixation to treat this kind of fracture in 1964. Later, some scholars reported that the transplantation of quadratus femoris muscle pedicle bone to the proximal femoral head fragment could increase the blood supply of the femoral head when intracapsular fracture took place.^{11,12} But other scholars opposed this operation and believed that it might increase the risk of complications.^{13,14} Meyers et al.¹⁵ pointed out that this operation would prolong the operative time by at least half an hour and required nice surgical skill and assistance. Furthermore,

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there is an increased risk of infection and nervi ischiadicus damage.¹⁶ In addition, the surgeon will disturb the normal blood circulation of the medical circumflex femoral artery, which is the primary intraosseous vessels of the femoral head.¹⁷ Therefore, some scholars persisted in using accurate reduction combining AO screw internal fixation for displaced femoral neck fractures in young patients. It is necessary to systematically review the two methods so as to make an optimal treatment protocol. The present study is to perform a meta-analysis including all the CCT studies in the last 10 years to determine whether there are any significant differences in terms of the fracture healing, good function of the hip joint, femoral head necrosis, and the time of fracture healing.

Materials and methods

Search strategy

We searched CCTs including randomized controlled study (RCT) and retrospective case study and compared the quadratus femoris muscle pedicle bone flap transplantation combining with hollow compression screw fixation and hollow compression screw fixation in the treatment of femoral neck fractures for Chinese young and middle-aged patients from Cochrane Library, Pubmed, CNKI, Chinese Biomedical Database, Wanfang Data published during the period of January 2005 to December 2014. The searched key words are *femoral neck fracture, quadratus femoris muscle pedicle bone flap, hollow compression screw fixation, and young patient*.

Inclusion criteria

The inclusion criteria were: (1) Chinese young adults with femoral neck fracture; (2) CCTs; (3) comparison of the quadratus femoris muscle pedicle bone flap transplantation combining with hollow compression screw fixation and hollow compression screw fixation for the treatment of femoral neck fractures; (4) the outcome being measured by the rate of fracture healing, the rate of good function of hip joint, the rate of femoral head necrosis, and the time of fracture healing.

Exclusion criteria

The exclusion criteria were: (1) case-based reports or reviews; (2) object of study and intervention measures failed to meet the inclusion criteria; (3) the original documents of experimental design being not precise; (4) studies with incomplete data.

Data extraction and quality assessment

Inclusion decisions were made independently by two reviewers according to the pre-stated eligible criteria. Disagreement in opinions between the two reviewers was resolved by discussion and a third reviewer was consulted as necessary. The criteria included seven items as follows: (1) whether to adopt the random sequence generation; (2) whether to use the principle of allocation concealment; (3) whether to use the principle of blinding for the subjects, implementers and measurement; (4) whether to use incomplete data and selective report; (5) whether there is any other bias. The relevant data recorded in this study included: first author's name, publishing year, sample size of quadratus femoris muscle pedicle bone flap transplantation combined with hollow compression screw fixation and hollow compression screw fixation, country of origin, duration of follow-up, the rate of fracture healing, the rate of good function of hip joint, the rate of femoral head necrosis, and the time of fracture healing.

Statistical analysis

Data were independently input into the RevMan 5.0 Meta-analysis Software Program by two reviewers. Dichotomous outcomes were expressed in terms of Odds ratio (OR), and the weighted mean difference (WMD) was used for continuous outcomes, both with 95% confidence intervals (CI). Heterogeneity was tested by using the Chi-square test and the I^2 test. A fixed-effects model was chosen when there was no statistical evidence of heterogeneity and random-effect model was adopted if significant heterogeneity was found. If the heterogeneity was found, we checked the study population, treatment, outcome and methodologies to determine the source of heterogeneity. If it could not be quantitatively synthesized or had too low rate to be measured, we used qualitative evaluation. A funnel plot was applied to assess the presence of publication bias.

Results

A total of 325 potentially relevant articles were identified. After screening all the titles and abstracts, 277 studies were excluded. After reading all the full-text of 48 studies, 8 studies including 800 patients met all the inclusion criteria.^{18–25} Quality was evaluated by the Newcastle-Ottava (NOS) score.²⁶ The total score is 10 points. Below 5 points is defined as low quality paper, while above 6 is regarded as medium quality paper, and above 8 is as high quality paper. Among them, there were 5 high quality papers and 3 medium quality papers (Table 1).

Rate of fracture healing

There was statistical difference between two groups [OR = 5.43, 95% CI (2.89, 10.20), $p < 0.05$, Fig. 1]. The results suggested that the rate of fracture healing was higher by using the transplantation of quadratus femoris muscle pedicle bone flap.

Rate of good function of hip joint

There was statistical difference between two groups [OR = 5.43, 95% CI (2.89, 10.20), $p < 0.05$, Fig. 2]. The results suggested that the rate of good function of hip joint was higher by using the transplantation of quadratus femoris muscle pedicle bone flap.

Rate of femoral head necrosis

There was statistical difference between two groups [OR = 4.21, 95% CI (2.02, 8.76), $p < 0.05$, Fig. 3]. The results suggested that the rate of femoral head necrosis was lower by using the transplantation of quadratus femoris muscle pedicle bone flap.

Time of fracture healing

There was statistical difference between two groups [WMD = -46.85, 95% CI (-65.13, -28.56), $p < 0.05$, Fig. 4]. The results suggested the time of fracture healing was shorter by using the transplantation of quadratus femoris muscle pedicle bone flap.

Publication bias

A strict quality assessment was carried out in the meta-analysis process. All the studies are CCT and the possibility of bias is low. But the funnel figure showed that there was a small bias, which might be associated with the incomplete collection of relevant literature, insufficient sample size and the different levels of clinical

Table 1
Message of documents.

Author	Year	Study design	Quadratus femoris muscle flap/AO hollow compression screw (cases)	Follow-up (month)
Zheng B et al.	2013	RCT	56/44	12
Lu XB et al.	2014	RCT	122/103	12
Cha QL et al.	2014	Retrospective	40/40	6
Liu Y et al.	2014	RCT	18/16	—
Xie YH et al.	2013	RCT	25/40	27
Liu P et al.	2010	Retrospective	20/18	28
Guo WK et al.	2013	Retrospective	21/19	36
Tang JP et al.	2005	Retrospective	33/22	39

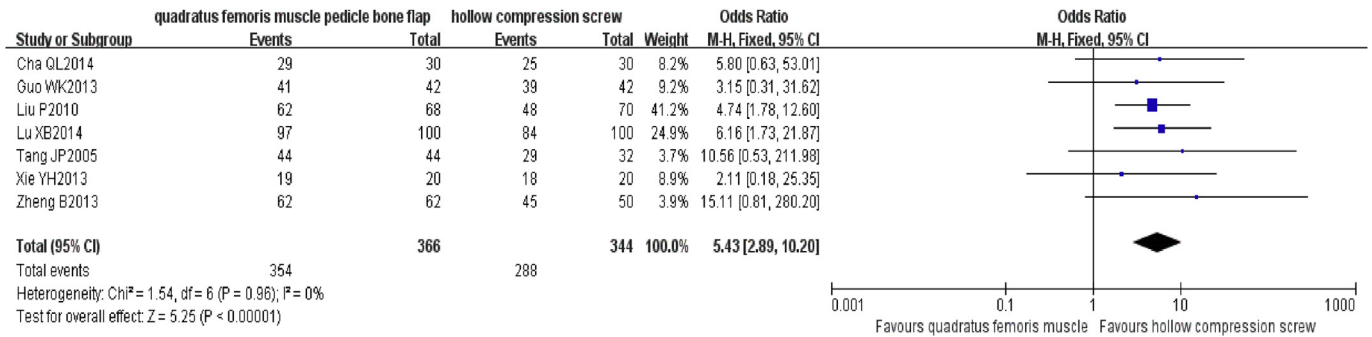


Fig. 1. The forest plot of the rate of fracture healing after operation between two groups.

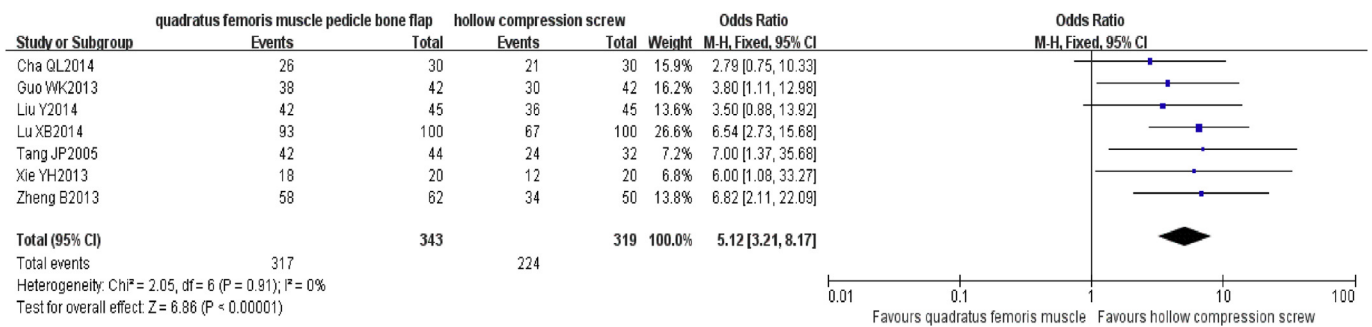


Fig. 2. The forest plot of the rate of good function of hip joint after operation between two groups.

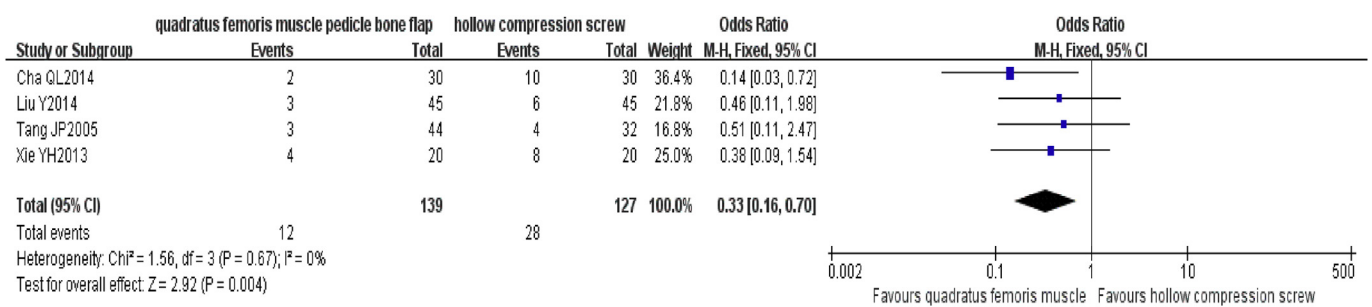


Fig. 3. The forest plot of the rate of femoral head necrosis after operation between two groups.

physicians. Sensitivity analysis is well qualified concerning the overall results (Figs. 5–7).

Discussion

The treatment of displaced femoral neck fracture in young adults is always a challenging task for orthopedic surgeons, which has been described as the unsolved fracture.⁷ This kind of fracture often

results from high-energy trauma and the fracture has a vertical fracture plane and marked displacement, which is prone to nonunion and osteonecrosis. Furthermore, majority of these fractures have a posterior bony defect or comminution in the femoral neck, which definitely increases the instability.²⁷ At present, almost all the scholars believe that operation is the favored technique for this kind of intra-articular fracture.¹¹ Many surgical procedures have been used for treating the fracture with varying success.^{18–25} Some

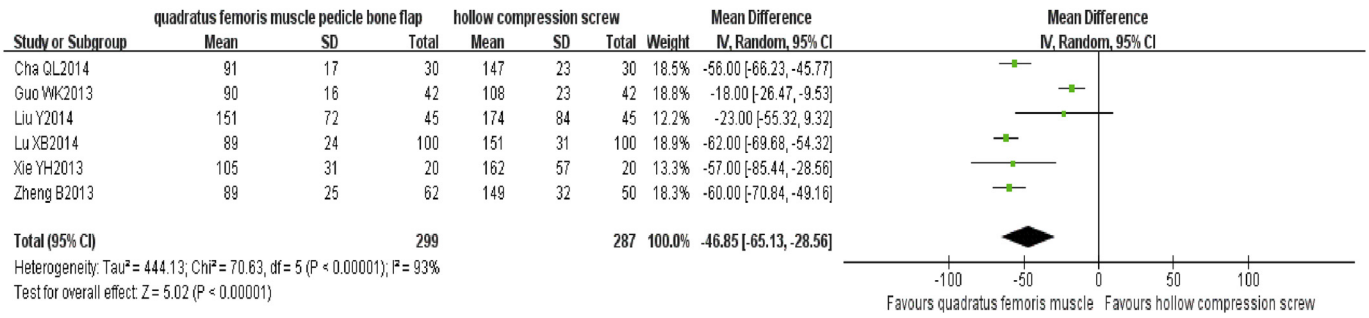


Fig. 4. The forest plot of the time of fracture healing after operation between two groups.

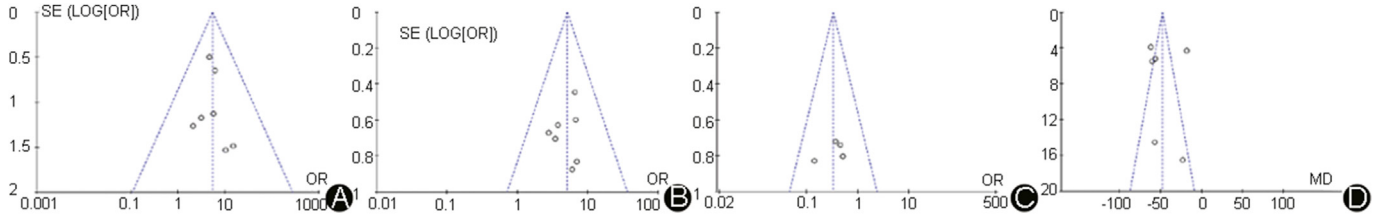


Fig. 5. The funnel figures of the evaluation projects. A: the rate of fracture healing; B: the rate of good function of hip joint; C: the rate of femoral head necrosis; D: the time of fracture healing.

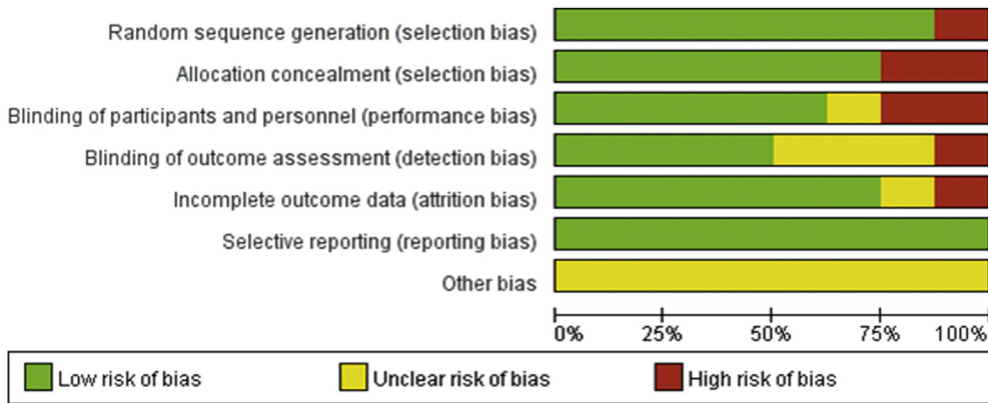


Fig. 6. Each risk of bias item is presented as a percentage across all included studies and indicates the proportional level for each risk of bias item.

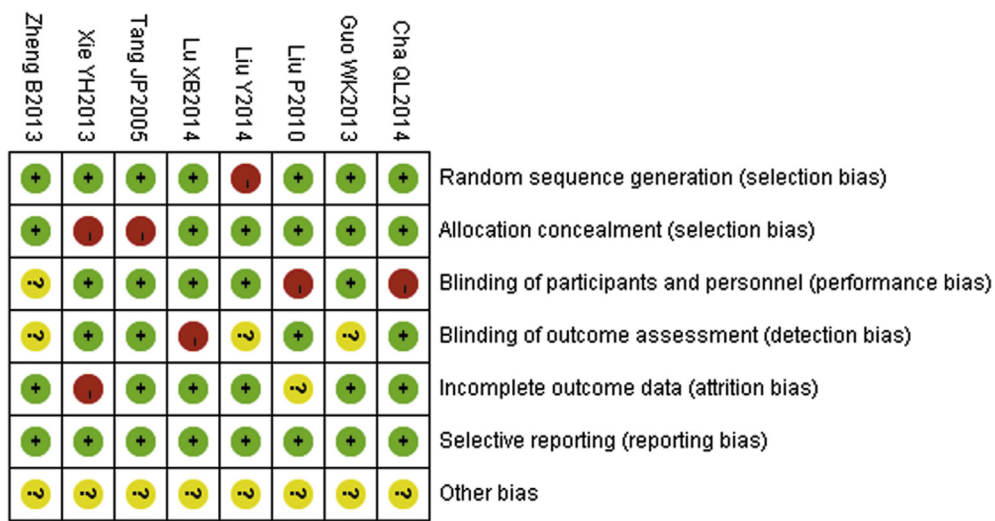


Fig. 7. Methodological quality of the included studies. This risk of bias tool incorporates assessment of randomization (sequence generation and allocation concealment), blinding (participants, personnel and outcome assessors), completeness of outcome data, selection of outcomes reported and other sources of bias. The items are scored with “yes”, “no”, or “unsure”.

scholars believed that the best treatment protocol was accurate reduction and internal fixation. But others persisted that it is necessary to transfer the quadratus femoris muscle pedicle bone flap in addition to the above method.^{8,10,18–25} They pointed out that the quadratus femoris muscle pedicle bone flap transplantation can not only treat femoral neck fracture, but also treat revascular femoral head.⁵ Vascular pedicle grafts, using a strut of iliac crest or a segment of fibula, can achieve a good result but was found to be technically demanding. The quadratus femoris muscle originates on the lateral aspect of the ischial tuberosity and ends at the trochanteric crest. The surgeons choose it for its proximity to the femoral head and low incidence of anatomic variance. Moreover, the quadratus femoris muscle pedicle bone graft has the advantages of vascularity to the femoral head and also a buttress for the posterior femoral neck defect, thereby enhancing stability. But this operation would increase the risk of infection and potential complications.

The purpose of this study, focusing on the efficacy and safety of quadratus femoris muscle pedicle bone flap transplantation, was to provide an insight into the options for treating displaced femoral neck fracture for Chinese young and middle-aged patients. From this meta-analysis, the rate of fracture healing showed statistical difference between quadratus femoris muscle pedicle bone flap transplantation combined with hollow compression screw fixation and AO hollow compression screw fixation for displaced femoral neck fracture. The rate of fracture healing was significantly higher in quadratus femoris muscle pedicle bone flap transplantation group. In regard to the rate of good function of the hip joint, the rate of femoral head necrosis, the time of fracture healing, the transplantation of quadratus femoris muscle pedicle bone flap showed a better result compared to another group.

Our meta-analysis has some limitations. First, only 8 CCTs were included in this study. Second, the follow-up period was not long enough to confirm the results. Third, all the retrieved documents were Chinese and there may be language bias.

In conclusion, this study suggested that transplantation of quadratus femoris muscle pedicle bone flap could promote the fracture healing of femoral neck fracture for Chinese young adults. In the future study we hope that there will be more multicentre, large-scale and high quality CCTs to further prove the conclusion.

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References

- Roshan A, Ram S. The neglected femoral neck fracture in young adults: review of a challenging problem. *Clin Med Res*. 2008;6:33–39. <https://doi.org/10.3121/cmr.2008.752>.
- Thuan VLY, Swiontkowski MF. Management of femoral neck fractures in young adults. *Indian J Orthop*. 2008;42:3–12. <https://doi.org/10.4103/0019-5413.38574>.
- Azam MQ, Iraqi AA, Sherwani MKA, et al. Free fibular strut graft in neglected femoral neck fractures in adult. *Indian J Orthop*. 2009;43:62–66. <https://doi.org/10.4103/0019-5413.45325>.
- Gautum VK, Anand S, Dhaon BK. Management of displaced femoral neck fractures in young adults (a group at risk). *Injury*. 1998;29:215–218.
- Davidovitch RI, Jordan CJ, Egoi KA, et al. Challenges in the treatment of femoral neck fractures in the nonelderly adult. *J Trauma*. 2010;68:236–242. <https://doi.org/10.1097/TA.0b013e3181c428ce>.
- Marti RK, Schuller HM, Raaymakers EL. Intertrochanteric osteotomy for non-union of the femoral neck. *J Bone Jt Surg Br*. 1989;71:782–787.
- Ballmer FT, Ballmer PM, Baumgaertel F, et al. Pauwels osteotomy for nonunions of the femoral neck. *Orthop Clin North Am*. 1990;21:759–767.
- Gupta A. The management of ununited fractures of the femoral neck using internal fixation and muscle pedicle periosteal grafting. *J Bone Jt Surg Br*. 2007;11:1482–1487.
- Doi K, Sakai K. Vascularized periosteal bone graft from the supracondylar region of the femur. *Microsurgery*. 1994;15:305–315.
- Judet R, Judet J, Launois B, et al. Trial of experimental revascularization of the femoral head. *Rev Chir Orthop Reparatrice Appar Mot*. 1966;52:277–303.
- Li WG, Li YJ, Yun H. A new operation for reconstruction of the femoral neck. *J Bone Jt Surg Br*. 1994;76:988–990.
- Baksi DP. Internal fixation of ununited femoral neck fractures combined with muscle-pedicle bone grafting. *J Bone Jt Surg Br*. 1986;68:239–245.
- Meyers MH. The role of posterior bone grafts (muscle-pedicle) in femoral neck fractures. *Clin Orthop Relat Res*. 1980;152:143–146.
- Leung PC, Shen WY. Fracture of the femoral neck in younger adults. A new method of treatment for delayed and nonunions. *Clin Orthop Relat Res*. 1993;295:156–160.
- Meyers MH, Harvey Jr JP, Moore TM. Delayed treatment of subcapital and transcervical fractures of the neck of the femur with internal fixation and muscle pedicle bone graft. *Orthop Clin North Am*. 1974;5:743–756.
- Bhuyan BK. Augmented osteosynthesis with tensor fascia latae muscle pedicle bone grafting in neglected femoral neck fracture. *Indian J Orthop*. 2012;46:439–446. <https://doi.org/10.4103/0019-5413.97263>.
- LeCroy CM, Rizzo M, Gunneson EE, et al. Free vascularized fibular bone grafting in the management of femoral neck nonunion in patients younger than fifty years. *J Orthop Trauma*. 2002;16:464–472.
- Tang JP, Jiang SW, Luo Q, et al. Clinical observation of femoral neck fracture in middle-age with three different methods. *Chin J Orthop Trauma*. 2005;7:396–399.
- Guo WK, Huang J, Wang J. Study of surgical operation for treatment of femoral neck fracture in young adults. *Chin Mod Med*. 2013;22:47–48.
- Liu P, Li Y. Two methods of surgical operation for treatment of femoral neck fracture in young adults. *J Taishan Med Coll*. 2010;3:218–219.
- Xie YH, Wang FL, Lin CX, et al. The hollow compression screw fixation combined with quadratus femoris muscle pedicle bone flap transplantation to treat the fracture of femoral neck fracture in young adults. *J Guangdong Med Coll*. 2013;5:571–572.
- Zheng B, Cao XL, Zhong L, et al. Clinical application of different treatments in young and middle-aged femoral neck fracture. *Med Innov Chin*. 2013;32:101–103.
- Liu Y, Wang JM. The comparison of the methods in treating femoral neck fracture: with or without the transplantation of quadratus femoris muscle pedicle bone flap. *Chin Foreign Med Treat*. 2014;15:90–91.
- Zha QL, Zhang HC, Lu CY, et al. Quadratus femoris muscle pedicle bone flap transplantation combined with hollow compression screw fixation versus AO hollow compression screw fixation in the repair of femoral neck fracture in young and middle-aged patients. *Chin J Tissue Eng Res*. 2014;48:7792–7796.
- Lu XB, Cui JY, Guo BT, et al. The comparison of two methods in treating the femoral neck fracture with or without quadratus femoris muscle pedicle bone flap transplantation. *Chin J Clin Ration Drug Use*. 2014;10:145–146.
- Stang A. Critical evaluation of the Newcastle-Ottawa scale for the assessment of the quality of nonrandomized studies in meta-analyses. *Eur J Epidemiol*. 2010;9:603–605. <https://doi.org/10.1007/s10654-010-9491-z>.
- Protzman RR, Burkhalter WE. Femoral-neck fractures in young adults. *J Bone Jt Surg Am*. 1976;5:689–695.