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Original Article

Outcome of bone marrow instillation at fracture site in intracapsular fracture of femoral neck treated by head preserving surgery

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ABSTRACT

Purpose: The aim of present study is to evaluate the outcome of bone marrow instillation at the fracture site in fracture of intracapsular neck femur treated by head preserving surgery.

Methods: This study included 32 patients of age group 18–50 years with closed fracture of intracapsular neck femur. Patients were randomized into two groups as per the plan generated via www.randomization.com. The two groups were Group A (control), in which the fracture of intracapsular neck femur was treated by closed reduction and cannulated cancellous screw fixation, and Group B (intervention), in which additional percutaneous autologous bone marrow aspirate instillation at fracture site was done along with cannulated cancellous screw fixation. Postoperatively the union at fracture site and avascular necrosis of the femoral head were assessed on serial plain radiographs at final follow-up. Functional outcome was evaluated by Harris hip score.

Results: The average follow-up was 19.6 months. Twelve patients in each group had union and 4 patients had signs of nonunion. One patient from each group had avascular necrosis of the femoral head. The average Harris hip score at final follow-up in Group A was 80.50 and in Group B was 75.73, which was found to be not significant.

Conclusion: There is no significant role of adding on bone marrow aspirate instillation at the fracture site in cases of fresh fracture of intracapsular neck femur treated by head preserving surgery in terms of accelerating the bone healing and reducing the incidence of femoral head necrosis.

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Introduction

Femoral neck fracture remains the unsolved problem in terms of union rate and avascular necrosis (AVN). Lu-Yao et al.¹ in his meta-analysis reported nonunion rate of 23%–37% and AVN rate of 11%–19%. In current literature various treatment modalities are available to treat fracture of intracapsular neck femur (ICNF). This includes 2/3/4 cannulated cancellous screw (CCS), sliding hip screw with or without derotation screw, valgus osteotomy and muscle pedicle bone grafting procedure. All have varied indications, limitations and overall outcomes.² The factors that influenced the union rate are posterior comminution, vertical fracture line, injury-surgery duration, etc.^{3–5}

There has been scanty literature available using bone marrow aspirate at the fracture site in fresh fracture of ICNF.⁶ However, autologous bone marrow has been used to enhance osteogenesis in long bone diaphyseal fractures and was found effective in stimulating bony union in delayed and nonunion cases treated by plating/intramedullary nailing/external fixation.⁷ Therefore in this study we have involved the two groups of patients of fresh fracture of ICNF in young adults (18–50 years) undergone close reduction and CCS fixation. The study group was additionally being subjected with autologous bone marrow aspirate instillation at fracture site⁶ through capsule of the hip joint and was assessed for the role of bone marrow in fracture union of ICNF and AVN of the femoral head.

Materials and methods

Thirty two patients who fulfilled the inclusion criteria were included in this study and were operated upon during the period of

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December 2011 to April 2013. Inclusion criteria were: patients of 18–50 years old and either sex with closed, traumatic fracture of ICNF injury duration <3 weeks. Patients with polytrauma, ipsilateral fracture of shaft femur, open injury, pathological fracture, patient on oral/injectable steroids, clinically detectable major illness, fracture of neck femur not suitable for CCS fixation, and patients not willing to give consent/participate in the study were excluded from the study. All patients fulfilling the inclusion criteria of the study were included after taking informed consent in writing. After clinical assessment and appropriate stabilization of the patient, an X-ray of anteroposterior (AP) and lateral views of bilateral hip and AP view of involved hip in 20° internal rotation were taken for documentation of fractures. The fracture was classified according to Garden Classification^{2,8} into stable (Garden type I and II) and unstable (Garden type III and IV) fractures. The patients were randomized into two groups as per the plan generated via www.randomization.com. The two groups were: Group A (control): fracture of ICNF treated by closed reduction and CCS fixation; Group B (intervention): fracture of ICNF treated by closed reduction and CCS fixation with percutaneous autologous bone marrow aspirate instillation at fracture site. Under suitable anaesthesia, the patients were taken for closed reduction on a fracture table. Closed reduction was attempted under image intensifier control. Garden's alignment index was used for assessment of adequacy of reduction.^{9,10} After obtaining satisfactory closed reduction, the fracture of neck femur was fixed internally with 3 CCS as per standard technique.^{9,10} In Group B additionally 6–8 ml of autologous bone marrow was aspirated from the ipsilateral iliac crest (Fig. 1). At the end of osteosynthesis, the affected hip joint was first aspirated by a wide bore needle (16 gauge) to prevent the raise in intracapsular tamponade. Then the bone marrow was injected intracapsularly through the same needle under the image intensifier control (Fig. 2). Patients were allowed to sit in bed on the 1st day after



Fig. 1. Aspiration of bone marrow from ipsilateral iliac crest using bone marrow needle (Group B).

surgery. Toe touch nonweight bearing with two crutch walking was allowed as long pain was tolerated. Patients were followed up clinically at 2 weeks, and then every 6 week till union at fracture site occurred and thereafter at every 6 months. Radiological assessment of the fracture was done by serial AP view in 20° internal rotation and lateral view taken at each follow-up. They were examined for surgical site infection, pain on VAS scale, hip range of motion and limb length discrepancy if any. The mean follow-up period was 19.6 months (range 16–28 months). Fracture union was assessed on plain radiograph and was taken as positive if fracture line becomes indistinct/not appreciable and there is no sclerosis at fracture margins. Early loss of reduction was assessed by change in Garden alignment index, neck shaft angle and implant back out. AVN of femoral head was assessed on plain radiograph at final follow-up. The function of the operated hip was evaluated by Harris hip scoring system at the final follow-up.

Results

A total of 32 patients who met the inclusion criteria were operated upon during the study duration. Two patients from Group A were lost to follow up after 11 months; the rest were followed up for mean follow-up period of 19.6 months (range 16–28 months). There were 25 males (79%) and 7 females (21%) in the study population. The mean age of the patients was 39.5 years (range 18–50 years). Eighteen patients had fracture due to fall from height, 13 following road traffic accidents and one due to physical assault. Eleven patients had Garden type III and 3 patients had Garden type IV fractures in Group A; while Group B had 8 Garden type III and 6 had Garden type IV fractures and rest of the patients had Garden type II in both groups. There was no statistically significant difference in both groups in terms of Garden classification (fracture subtypes, Fig. 3). The mean duration of injury to surgery was 5 days in Group A and 8 days in Group B.

In both groups, union was seen in 12 patients out of 16 with mean union time of 29 weeks (24–36 weeks) in Group A and 32 weeks in Group B (24–36 weeks, Fig. 4). There was no statistically significant difference in both groups in terms of union time ($p = 0.739$).

Nonunion was seen in 4 patients in each group. One patient out of 4 nonunion cases in Group B had undergone implant failure at 12 weeks of follow-up and was reoperated upon with Valgus osteotomy using double angle osteotomy blade plate. Subsequent follow-up of 12 months showed no signs of union and patient had developed implant failure with AVN changes in femoral head. Thus underwent total hip replacement (THR) subsequently.

One patient from each group had developed AVN of the femoral head. Group A patient was Garden type IV and had closed reduction at 6th day after injury, and had AVN at 18 months of follow-up. The patient was having good functional outcome and he was able to squat and sit cross legged and was able to manage his daily living activities with mild pain. Patient was not willing for any intervention. The other patient from Group B was Garden type III and developed implant failure at 12 weeks thus went for Valgus osteotomy procedure, and then developed nonunion with AVN changes in femoral head at 12 months of follow-up and finally underwent THR. The average Harris hip score at final follow-up in Group A was 80.50 and in Group B was 75.73, which was found to be not significant. In both groups there was no surgical site infection in any of the patient during postoperative follow-up.

The proportion of nonunion and AVN was compared between the two groups using a relative risk, which was 1.0667 and its 95% confidence interval was ± 0.16001 , ranging between 0.9067 and 1.2267 using the software of www.easycalculation.com. Therefore there is no significance of association with the type of treatment.

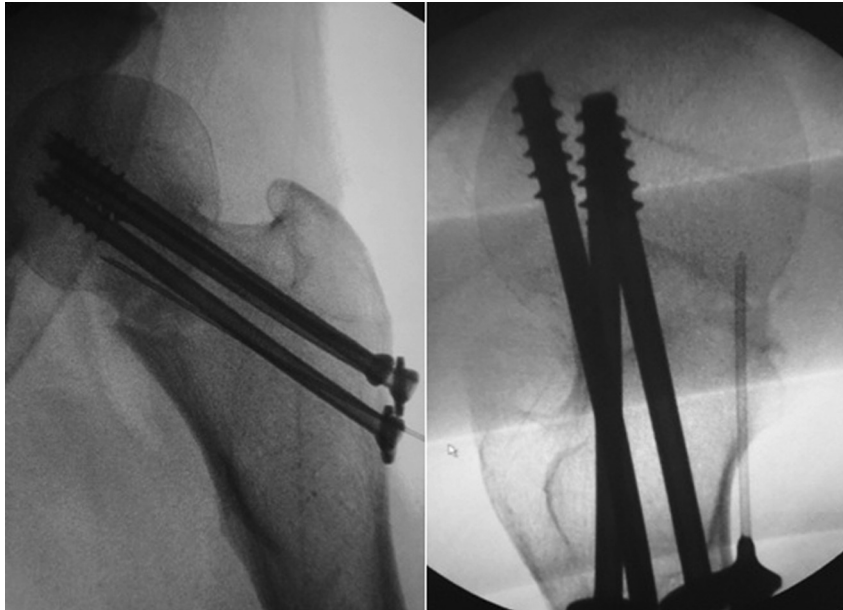


Fig. 2. Instillation of bone marrow at fracture site under image intensifier AP and lateral view (Group B).

Discussion

This study aims to find out the outcome of add on bone marrow instillation at fracture site in cases of fracture of ICNF managed by head preserving surgery. Our hypothesis was to justify the role of bone marrow instillation in cases of fracture of ICNF in terms of union and reducing AVN. As there are recommendations available in the literature about the role of autologous bone marrow instillation in delayed union and nonunion of long bone diaphyseal fracture.⁷

There is a paucity of literature on the role of autologous bone marrow aspirate in fracture of ICNF. To best of my knowledge there is only one study done by Lin et al.⁶ who had shown the role of bone marrow aspirate in fracture of ICNF treated by head preserving surgery. This is the first clinical study done to analyze the outcome of autologous bone marrow aspirate in fracture of ICNF treated by head preserving surgery.

Limitation of the study was small sample size taken with mean follow-up was around 19.6 months only and the exact technique and amount of bone marrow aspirate instillation at fracture site in fracture of ICNF were not known.

In our study of 16 patients in each group, 12 (75%) patients showed union and 4 (25%) patients in both groups had nonunion at final follow-up of 19.6 months, thus no significant difference was seen in terms of union in both groups ($p = 0.739$). In contrast, Lin et al.⁶ in a study of 60 patients, 30 cases of femoral neck fracture were treated by CCS fixation and percutaneous autologous bone

marrow aspirate instillation; while rest 30 cases were treated by CCS fixation only. He showed the union in 29 (96.67%) patients in intervention group as compared to union in 24 (80%) patients in control group at final follow-up of 2 years. Thus nonunion rate was 3.33% in intervention group and 20% in control group. His study concluded that using autogenous bone marrow grafting at fracture site in fracture of ICNF is a more efficient method for accelerating healing of femoral neck fracture and reducing femoral head necrosis. No significant difference was seen in our study with the type of treatment, which may be attributed to not known of exact technique and amount of bone marrow instillation at fracture site in fracture of ICNF.

However, our results of both groups were better than those of Rawal et al.¹¹ who did study in 27 patients of femoral neck fracture with posterior comminution fixed with 3 CCS and found there was nonunion in 8 (29.6%) patients at 1 year of follow-up period. Better results in terms of fracture union in our study maybe because Rawal et al. had included the patients of femoral neck fracture with posterior comminution only, a factor that is important cause of inse-cure fixation and nonunion.^{12,13}

In our study one patient from each group had AVN (6.25%) of femoral head at final follow-up. AVN of femoral head occurs due to several factors that are not in surgeon’s control. AVN can occur even with early anatomical reduction and rigid fixation of fracture of ICNF. Factors like raised intracapsular pressure,¹⁴ capsulotomy,¹⁵ injury to surgery duration,¹⁴ closed vs. open reduction¹⁶ are still controversial; osteonecrosis may be a result of the vascular damage

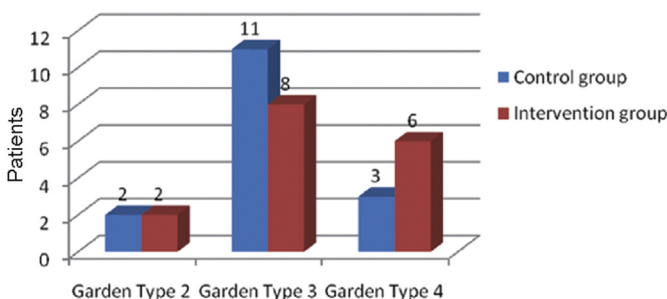


Fig. 3. Garden (fracture subtypes) distribution in both groups.

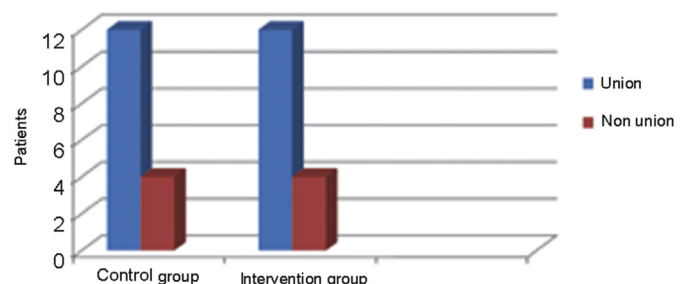


Fig. 4. Fracture union and nonunion in both groups at final follow-up.

that had occurred at the time of surgery.¹⁴ Lin et al.⁶ found that there was evidence of AVN in 1 (3.33%) case in the intervention group and 6 (20%) cases in the control group at 2 years of follow-up and had shown the percutaneous autogenous bone marrow grafting to be an efficient method in reducing femoral head osteonecrosis. There was no significant difference in both groups in terms of AVN in our study.

Rawal et al.¹¹ found that there was evidence of AVN in 6 (22.2%) patients at 1 year of follow-up period, while in our study in both groups AVN of femoral head in 1 (6.25%) patient. Better results in our study in terms of AVN may be due to the reason that Rawal et al. used bone scan in addition to plain X-ray for evaluation of AVN. However, the follow-up duration was shorter (1 year) than our study of 19.6 months.

Another study done by Mohammad et al.¹⁷ who used 2 CCS and fibular strut graft for fixation of femoral neck fracture in 33 patients found that there was nonunion in 6 (18%) patients and no AVN (0%) at mean follow-up period of 2 years as compared to our result of both groups with AVN rate of 6.25%. Better result by Mohammad et al. may be attributed to using strut fibular graft acting as biological implant for neovascularization due to osteoinductive and osteoconductive potential as compared to bone marrow instillation at fracture site done in our study as it contains osteoprogenitor cells that can be used to accelerate bone healing as documented in the literature of delayed union and nonunion of diaphyseal fracture of long tubular bones.¹⁸

The functional outcomes in our study in terms of Harris hip score at final follow-up was 80.50 in Group A and 75.73 in Group B, which was also found to be not statistically significant.

Compared to above all studies we concluded that there is no significant role of add on bone marrow aspirate instillation at fracture site in cases of fresh fracture of ICNF treated by head preserving surgery in terms of accelerating the bone healing and reducing the incidence of femoral head necrosis. However, this study included small group of patients (sample size). We need studies with larger group of patients with better methodology (exact technique and amount of bone marrow aspirate instillation) with longer follow-up to assess the role of add on marrow instillation at fracture site in fresh fracture of ICNF treated by head preserving surgery.

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