

Is Preemptive Free Fibular Strut Grafting with Stable Fixation in Fresh Displaced Fracture Neck of Femur in Young Adults, Effective in Prevention of Catastrophic Complication of Non-Union and Avascular Necrosis?

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ABSTRACT

Background: The fracture neck femur carries a threat of two catastrophic complications, nonunion (NU) and avascular necrosis (AVN), more so if it is displaced, in which the rate of NU is 9%-35%, and AVN 20%-35%. The treatment of displaced fractures in young patients is reduction and stable fixation to preserve the femoral head, but about 1/3rd of these patients suffer from NU and AVN. The challenges are, therefore, in finding solutions for prevention/reduction of complications. We, therefore, used pre-emptive fibular strut grafting in all fresh displaced fractures to ascertain its effectiveness in prevention/reduction of complications.

Material and Method: 72 patients aged 18-55 years (mean 37 years) with fresh (<3 weeks) displaced fractures were operated by closed reduction and fixation with two cancellous screws and fibular graft.

Results: 68 (94.44 %) patients achieved union within a mean period of 19.8 weeks, 4 (5.56 %) patients went into NU, and 3 (4.17%) patients despite union, showed signs of AVN. The mean follow up period was 24.83 months.

Conclusion: We hypothesize that reduction and stable fixation with two cancellous screws along with fibular graft appear quite effective in lowering the rate of NU and AVN, and moreover fibular grafting is inexpensive, easily procurable without any long term morbidity at the donor site. Therefore it may be used pre-emptively in all fresh displaced fractures in young patients to thwart the complications. Level of evidence: Level 3.

Key words: Fresh displaced Garden Type 3 & 4 Fracture, Fracture Neck Femur, Nonunion (NU), Avascular Necrosis (AVN), Preemptive, Free Fibular Graft.

Type-3: complete fracture with partial displacement with disruption of femoral head and acetabular trabecular alignment.

Type-4: complete fracture with complete displacement but with maintenance of femoral head and acetabular trabeculae alignment.

However, based on the biological behavior, fracture neck femur is broadly categorized into undisplaced fractures and displaced fractures. Garden type 1 and type 2 fractures are included in the category of undisplaced fractures, while Garden type 3 and type 4 fractures are included in the category of displaced fractures², as further differentiation has wide inter-observer variability.³

The intracapsular fracture neck femur is associated with two most dreaded complications like nonunion (NU), and avascular necrosis (AVN). The risk of NU is directly proportional to the degree of displacement. In undisplaced Garden type 1 and 2 fractures, the rate of NU is merely 0% to 5%⁴⁻⁷, while in displaced Garden type 3 and 4 fractures, the risk of NU is as high as 9% to 35%.^{4,6,8-12} The AVN of the head of the femur occurs as a result of increased intra capsular pressure, due to hematoma that compromises the femoral head blood flow and causes cellular death.¹³⁻¹⁵ The risk of AVN in undisplaced Garden type 1 and 2 fractures is about 15%, (commonly 5% to 8%).^{4,6-8,16-18}, while in displaced Garden type 3 and 4, it is as high as 9% to 35% (commonly between 20% to 35%).^{4,6-9,16,18,19}

The treatment of intracapsular fracture neck femur is essentially surgical until contraindicated due to some other medical reasons²⁰, as non-operative treatment is associated with high rates of non-union and mal-union.²¹

The treatment of undisplaced Garden type 1 and 2 fractures

INTRODUCTION

The intracapsular fracture neck femur is encountered frequently in geriatric population, because of weakening of bone as a consequence of osteoporosis, and is caused by a trivial trauma, while the younger patients sustain these fractures as a result of high velocity trauma in road traffic accidents.¹

The most popular classification, which is followed world over was described by Garden in 1961. It divides the fracture neck femur, based on the degree of displacement on anteroposterior (AP) radiograph, into four types² viz-

Type-1: incomplete fracture (valgus impacted)

Type-2: complete fracture but undisplaced

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does not pose any difficulty as these fractures are fixed in situ to avoid the chances of displacement in young as well as in elderly patients.²² The treatment of displaced Garden type 3 and 4 fractures in elderly patients above 65 years, who are otherwise infirm, low demanding, osteoporotic, is preferably hemi or total replacement arthroplasty, as it avoids the complications of NU and AVN.

But what about the younger patients suffering from fresh displaced Garden type 3 and 4 with a high risk of AVN, failure of fixation, and NU?²³ Although about 300000 articles are available in a Medline search for fracture neck femur, but they do not clearly define the best treatment protocol for these fractures.²⁴

Though all displaced fractures in young patients are treated surgically by reduction, preferably closed, and fixation, but if an acceptable reduction is not achievable or the posterior neck is comminuted, an open reduction and muscle pedicle bone grafting should be carried out.²⁵ But despite the anatomical reduction and stable fixation, the chances of AVN and NU do persist.

In 1935, Speed observed a complication rate of 36% after internal fixation of fractures of neck of femur. Recent reports of the meta analysis confirmed that 36% complication rate remains unchanged.^{26,27} Despite all these facts, the femoral head must, preferably, be saved in young patients, and therefore, these fractures should be reduced and fixed internally.²² The successful reduction and fixation gives best and everlasting results. Rodrigues et al. reported internal fixation to be the most harmless procedure for the fracture neck femur.²⁸ In young patients, the displaced fractures must be urgently reduced anatomically and fixed. But still 1/3rd of these patients suffer from NU or AVN and ultimately need replacement surgery.²⁹ The challenges are, therefore, in finding solutions, which might contribute in prevention or reduction of the risk of NU and AVN.

Based on these facts, we took up this study, and we treated all fresh displaced Garden type 3 and 4 fractures in young patients by reduction and internal fixation with two cannulated cancellous screws along with free fibular strut graft as a preemptive move towards the prevention or reduction of the catastrophic complications of NU and AVN of femoral head.

Through this study we have tried to ascertain the effectiveness of free fibular strut graft in prevention or reduction of chances of NU and AVN following displaced Garden type 3 and 4 fracture neck femur in young adults.

MATERIAL AND METHODS

In total 72 patients aged between 18 to 55 years with a mean age of 37 years, presenting with an isolated fresh (within 3 weeks) but displaced Garden type 3 and 4 fracture neck femur, were included in this prospective non blind study during a period of January 2010 to December 2013. Patients more than 55 years of age, patients below 55 years of age but presenting after 3 weeks with or without neck absorption, and patients with ipsilateral fracture shaft femur, were not included in the study. The fractures beyond 3 weeks

were excluded as these fractures are considered neglected according to Sandhu's classification of fracture neck femur and the management of which may be entirely different from fresh fractures.³⁰ Patients beyond 55 years of age were excluded as in patients beyond 55 years of age replacement arthroplasty may be considered as a preferable method of treatment, while in young patients it is always preferable to conserve the head. Patients with ipsilateral fracture shaft femur were not included as the treatment protocol of such combined fractures is also entirely different.

All patients were duly informed about the research study and a written informed consent for their participation in the study was obtained. All the procedures in the present study were carried out in accordance with Helsinki declaration. Present study was cleared and approved by the Research Ethics Committee of our Institution.

Out of the total number of patients 41(56.94%) had fracture in the left hip, while 31(43.06%) had involvement of the right hip. There were 44(61.11%) male patients and 28(38.89%) were females, with a male to female ratio of 1 : 0.64. 50 patients sustained Garden type 3 fractures, while 22 patients suffered from Garden type 4 fractures. The mode of injury in 39 patients was road traffic accidents, while 13 slipped on the floor and rest of the 20 patients suffered these fractures due to fall from stairs. All patients after admission were rested in bed with a pillow support under the knee of the affected limb to keep the hip joint in flexion, and external rotation to decrease the chances of vascular impairment to the head of femur. No patient was immobilized in Buck's extension traction or Thomas knee splint, as they keep the hip joint in extension, which is deleterious to the already compromised blood supply to the femoral head by increasing intracapsular pressure.^{31,32} In none of the patient, the hemarthrosis in the hip joint was aspirated due to its controversial role. All patients were operated under spinal anaesthesia, and C-arm control within 48 to 72 hours after admission, and all fractures were reduced close and stabilized with two cannulated cancellous screws along with a free fibular strut graft harvested from the ipsilateral leg.

Technique:- After the spinal anaesthesia, the patient is shifted to the fracture table. The fracture is reduced by simply applying traction and internal rotation and is confirmed by image intensifier in both AP and Lateral views. The part is prepared from umbilicus to ankle and draped meticulously. A longitudinal incision is made over the lateral aspect of thigh to expose the base of the trochanter subperiosteally. Three guide wires are passed from the base of trochanter to the subchondral bone. The inferior guide wire is passed close to the calcar so that placement of screw in this position help in preventing the varus collapse, and one guide wire is placed widely away in the posterosuperior portion of the head as placement of screw in this portion helps in preventing posterior angulation especially if there is posterior comminution.³³ The third guide wire is introduced in the center of the head in between the superior and inferior guide wires. Two cannulated screws are inserted over

the inferior and superior guide wires after reaming. Over the central guide wire a tunnel is created by reaming with the 8 mm part of the triple reamer. A fibular strut graft is harvested from the middle third of the ipsilateral leg through a posterolateral approach. The size of the graft is measured by the protruding portion of the wire. Multiple drill holes are made on the surfaces of the graft with a 2.5 mm drill bit, as it increases the chances of bony ingrowth into the head and neck and hasten early incorporation of the graft. The graft is then gently hammered inside the already prepared tunnel with the help of Smith Peterson nail introducer as its shape corresponds well with the trifine shape of the fibular graft. The wound is closed in layers.

RESULTS

During a period of 4 years from January 2010 to December 2013, we managed 72 fresh displaced Garden type 3 and 4 femoral neck fractures, in patients aged 18 to 55 years with a mean age of 37 years, by close reduction and fixation with two cannulated cancellous screws along with a free fibular strut graft, harvested from middle third of the ipsilateral leg under spinal anaesthesia and C-arm control, within 48 to 72 hours, after admission on a priority basis as an emergency case, with a mean delay of 38.9 hours in operation. The mean duration between injury and admission was 3.8 days (range 6hrs to 8 days). Postoperatively no immobilization was given except a pillow support under the knee joint of the operated limb. Non weight bearing ambulation with either the axillary crutches or walker support was allowed from 3rd to 5th postoperative day and was continued at-least for 6 to 8 weeks till the bridging trabeculae became evident on the radiographs, and then the partial weight bearing was allowed with crutch or walker support. Full weight bearing was allowed when the radiographs start showing complete bridging trabeculae at about 16 to 24 weeks.

All patients were regularly followed initially at monthly interval for the 1st three months and thereafter two monthly to quarterly for evaluation of union, pain in hip joint, range of movement, graft integration or breakage, any sign of screw loosening, non-union, and avascular necrosis. The mean follow up period was 24.83 (range, 12 to 36) months. Out of the total 72 patients, 68 (94.4%) patients achieved union within a mean period of 19.8 (range 16 to 24) weeks, however 4 (5.56%) patients had non-union, out of which, 3 patients showed fracture of the fibular grafts during follow up radiographs at 12 weeks. These 3 patients were immobilized by below knee skin traction on Thomas knee splint for a period of 8 weeks, but these patients went into non-union despite immobilization. These patients were advised revision surgery but none of them agreed for revision surgery and lost to the follow up. 3 (4.17%) patients despite fracture union showed signs of avascular necrosis during follow up radiographs at about 12 to 15 months. All the 3 patients had pain in hip joint, but were able to carry out their activities of daily living. None of these patients had segmental collapse at the time of detection of the AVN. They were explained about the prognosis and need for total hip replacement.

They have not yet planned for replacement surgery, but still are continuing in the follow up regularly. All patients who achieved uncomplicated union of fracture, returned to their pre-injury level by regaining almost all the functions of the affected limb within an average period of 8 to 10 months.

DISCUSSION

Because of the two catastrophic complications viz- NU and AVN of femoral head, the intracapsular fracture neck femur till date are labeled as unsolved fractures, and therefore the fresh displaced Garden type 3 and 4 in young patients are considered as an emergency, and the literature advocates early reduction with stable fixation preferably within 6 to 12 hours.³⁴

Way back in 1930, with the advent of Smith Peterson nail, the femoral neck fractures were started to be internally fixed but the results in Garden type 3 and 4 fractures were not very impressive and the failure rate was 70.9% including NU and AVN.³⁵ The implants and techniques kept on improving (like Deyerle pins, Pugh sliding nail plate, Richard's sliding nail etc.), though with a lower rate of NU as compared to the Smith Peterson nail but none was foolproof, and NU and AVN, still today, are the most feared complications of displaced femoral neck fractures.

Several procedures have been defined in the literature for the treatment of NU and AVN viz- Meyer, Harvey and Moore³⁶, and Baksi muscle pedicle bone graft³⁷, vascularized fibular grafting, free fibular strut grafting, McMurray's displacement osteotomy³⁸, and finally total hip replacement, but nothing much is available in the literature regarding procedures to prevent or reduce the incidence of NU and AVN following displaced femoral neck fractures.

Then we thought, can something be done which could be effective in either preventing or decreasing the incidence of NU and AVN in fracture neck femur, similar to the cases of comminuted diaphyseal fractures of long bones, in which we perform preemptive cancellous bone grafting in an effort to thwart the chances of non-union?

We, then, started performing a preemptive fibular strut grafting in all cases of fresh displaced Garden type 3 and 4 in young patients to thwart the possibility of NU and AVN. We opted free fibular strut graft for the reasons that, it is a cortical graft and hence provides a good mechanical support and also gives rotational stability because of its triflanged shape, have reasonably good osteoinductive and osteoconductive properties and works as a biological implant for revascularization, prevents segmental collapse of the head if the avascular necrosis ensues, ultimately gets amalgamated with the host bone, and is easy to harvest with no long term donor site morbidity.

The role of free fibular grafts has been extensively evaluated for the treatment of established cases of NU and AVN before the segmental collapse of the femoral head.^{30,39-41} Yadav SS pioneered the idea of biological fixation by using double fibular strut grafts.⁴² But there is a dearth of articles exclusively on the role of free fibular graft in prevention or reduction in the incidence of NU and AVN in young

patients suffering from fresh displaced fracture neck femur. Though SS Yadav⁴², ON Nagi⁴³, and Hardas Singh Sandhu³⁰ have carried out free fibular strut grafting in fresh displaced fractures also, but they did it along with the neglected fractures (>3 weeks) in the same study. However none of them have evaluated the percentage of union / non-union, development of AVN exclusively in fresh fractures only, rather they have documented their results in total number of patients treated by fibular grafts. In our study of 72 fresh displaced Garden type 3 and 4 fractures of neck of femur in young patients with a mean age of 37 years (range 18 to 55), treated with two cannulated cancellous screws along with a free fibular strut graft, 68 (94.4 %) patients achieved union within a mean period of 19.8(range16 to 24) weeks and only 4 (5.56%) patients went into NU. 3 (4.17%) patients developed AVN despite fracture union. In our study the rate of NU and AVN was merely 5.5% and 4.1% respectively, which is well below the quoted rates of 9% to 35% for NU^{4-6,8,10-12}, and a similar rate, though most of the series quote about 20% to 35% for AVN^{4,6-9,16,18,19}, in the literature. After the critical analysis of results obtained in our study, we hypothesize that near normal reduction with stable fixation with two cannulated cancellous screws, if augmented with a preemptive free fibular strut graft in fresh displaced Garden type 3 and 4 fractures in young patients appears to be quite effective in bringing down the rates of NU and AVN to lower levels.

Limitations

However, despite the promising results obtained, we accept limitations of our study that it was a non randomized one, and therefore several multicentric randomized trials must be conducted to support our hypothesis.

CONCLUSION

We conclude that free fibular strut grafting is quite worthy, inexpensive, easily procurable without any long term morbidity at the donor site, and therefore it may be used preemptively in all fresh displaced Garden type 3 and 4 fracture neck femur in young patients to thwart its catastrophic complications of NU and AVN. The procedure is simple, does not require costly and sophisticated instrumentation, can be done by an average orthopaedic surgeon even at the district level hospitals if the facility of image intensifier is available.

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