



Appraisal of Outcome of Fibular Strut Graft Augmentation in the Treatment of Fresh Displaced Intracapsular Fracture Neck Femur in Young Adults

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Abstract

Background: The displaced fracture neck femur carries a threat of two catastrophic complications viz non-union (NU) and avascular necrosis (AVN) with a rate of 9%-35%, and 20%-35% respectively. The usual treatment of displaced fracture in young adults is anatomical reduction and stable fixation to preserve the femoral head, but about 1/3rd patients suffer from NU and AVN. The challenges are, therefore, in finding solutions for prevention/reduction of complications. To confront these challenges, we used fibular strut graft in all fresh displaced fractures to augment the union process.

Material and Method: A total of 32 patients aged 18-55years (mean age 37 years) with fresh (<3weeks) displaced fractures were operated by closed reduction and fixation with two cancellous screws and one fibular strut graft.

Results: Out of the total 32 patients, 27 (84.375%) achieved fracture union within a mean period of 19.8 weeks, while 05 (15.625%) went into NU. However, 3 (9.37%) patients despite union developed AVN of femoral head. The mean follow-up period was 24.83 months.

Conclusion: We hypothesize that reduction and stable fixation with two cancellous screws along with a fibular strut graft appears an effective treatment modality in lowering the rate of NU and AVN. Moreover, fibular strut graft is inexpensive and is easily procurable causing no long-term morbidity at the donor site. Therefore, in our opinion, fibular strut graft may be used in all fresh displaced fractures in young patients to thwart the complications of NU and AVN.

Keywords: Fresh displaced Garden type 3 & type 4 fracture; Fracture neck femur; Nonunion (NU); Avascular necrosis (AVN); Fibular strut graft

Introduction

The intracapsular fracture neck femur is encountered frequently in geriatric population, due to weakening of bones as a consequence of osteoporosis, and is usually caused by trivial trauma, while the younger patients sustain these fractures as a result of high velocity trauma in road traffic

accidents or fall from height [1].

The most popular classification, which is followed world over, was described by Garden in 1961 which, based on the degree of displacement on anteroposterior (AP) radiograph, divides the fracture into four types [2] viz-

Type-1: Incomplete fracture (valgus impacted).

Type-2: Complete fracture but undisplaced.

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, intracapsular 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 fractures [2]. Any 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 type 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 type 2 fractures is about 15%, (commonly 5% to 8%) [4,6-8,16-18] while in displaced Garden type 3 and type 4, it is as high as 9% to 35% (commonly between 20% to 35%) the treatment of intracapsular fracture neck femur is essentially surgical until contraindicated due to some other medical reasons [20]. As non-operative treatment is associated with high rates of non-union and mal-union [21].

The treatment of undisplaced Garden type 1 and type 2 fractures 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 type 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 type 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]. All displaced fractures in young patients are treated surgically by reduction, preferably closed and stable fixation. But in the event of failure to achieve acceptable reduction or if there is posterior comminution, an open reduction and muscle pedicle bone grafting is recommended [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 anatomically reduced and fixed internally [22]. The successful reduction and fixation give 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 suffers 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 all these facts, we took up this study to confront the challenges of NU and AVN. In the present study we treated all fresh displaced Garden type 3 and type 4 fractures in young patients by anatomical reduction and stable internal fixation with two cannulated cancellous screws along with free fibular strut graft augmentation to ascertain its effectiveness in prevention or reduction of chances of NU and AVN.

Material and Method

In total 32 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 March 2020 to February 2023. Patients presenting with more than 3 weeks old fractures were excluded as these fractures are considered neglected according to Sandhu's classification of intracapsular fracture neck femur and the management of which may be entirely different from fresh fractures [30]. Patients beyond 55 years of age were also excluded as in these patients replacement arthroplasty may be considered as a preferable method of treatment. Patients with ipsilateral fracture shaft femur were also not included as the treatment protocol of such combined fractures is also entirely different. Out of the total number of patients 18 (56.25%) had fracture of the left hip, while 14 (43.75%) had fracture of the right hip. There were 21 (65.625%) male patients and 11 (34.375%) females. Twenty-three (71.875%) patients sustained Garden type 3 fractures, while 09 (28.125%) patients had Garden type 4 fractures. The mode of injury in 24 (75%) patients was road traffic accidents, while 08 (25%) patients had fall from height.

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 bring 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 greater trochanter subperiosteally. Three guide wires are passed from the base of greater 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 triflanged shape of the fibular graft. The wound is closed in layers (Figures 1 & 2).

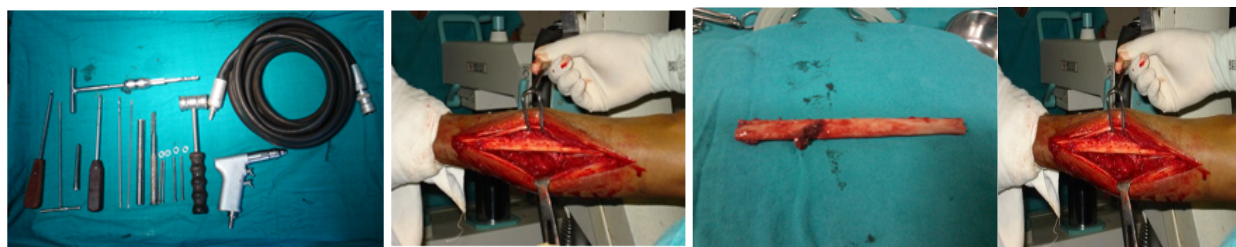


Figure 1: Instrumentation & Fibular Strut Graft.

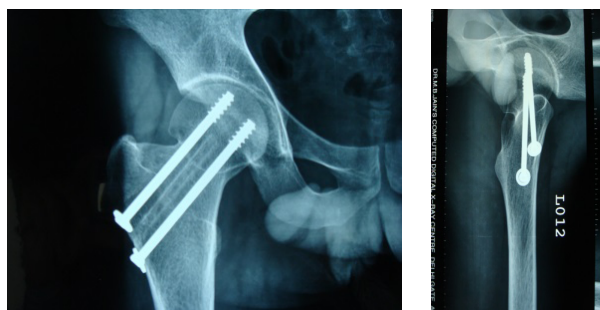


Figure 2: Postoperative X-rays AP & Lateral Views.

Results

During a period of 3 years from March 2020 to February 2023, we managed 32 fresh displaced Garden type 3 and type 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 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, when the partial weight bearing was allowed with crutch or walker support. Full weight bearing was allowed when the radiographs start showing complete bridging trabeculae between 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 32 patients, 27 (84.375%) patients achieved union within a mean period of 19.8 (range 16 to 24) weeks, 05 (15.625%) patients went into non-union, and 03 (9.37%) patients showed signs of AVN despite the fracture union on follow-up radiographs between 12 to 15 months. Out of the 05 patients of NU 02 patients showed fracture of the fibular grafts during follow up radiographs at 12 weeks for which they were immobilized by below knee skin traction on Thomas knee splint for a period of 8 weeks but fracture failed to unite. All the 3 patients of AVN 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 in near future. 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 femoral neck fractures till date are considered as “unsolved fractures”, and therefore the fresh displaced Garden type 3 and type 4 fractures 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 type 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, Moore [36], and Baksi muscle pedicle bone graft [37]. Vascularized, grafting, free fibular strut grafting, McMurray’s displacement osteotomy [38] 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. In this present study we augmented the cancellous screw fixation with a fibular strut graft in all cases. The free fibular strut graft is opted for the reasons that being cortical in nature and triflanged in shape it provides a good mechanical support as well as rotational

stability. It also has reasonably good osteoinductive and osteoconductive properties and works as a biological implant for revascularization and may also prevent segmental collapse of the head if the avascular necrosis ensues. It ultimately amalgamates 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 strut grafts in prevention or reduction in the incidence of NU and AVN in young patients suffering from fresh displaced fracture neck femur. Though Yadav SS [42], Nagi ON, et al. [43], and Hardas Singh Sandhu [30] also carried out free fibular strut grafting in fresh displaced fractures but they also included the neglected fractures (>3 weeks) in the same study. Moreover, none of them evaluated the percentage of union, non-union, and development of AVN exclusively in fresh fractures only, rather they documented their results in total number of patients treated by fibular grafts including fresh as well as the neglected ones.

In our study of 32 fresh displaced Garden type 3 and type 4 fractures of neck of femur in young patients with a mean age of 37 years (range 18 to 55), were treated with two cannulated cancellous screws along with a free fibular strut graft. Out of 32 patients, 27 (84.375 %) patients achieved union within a mean period of 19.8(range16 to 24) weeks, 05 (15.625%) patients went into NU, and 03 (9.37%) patients developed AVN despite fracture union. In our study the rates of NU and AVN was merely 15.6% and 9.3% respectively, which are well below the quoted rates of 9% to 35% for NU [4-6,8,10-12], and 20% to 35% for AVN [4,6-9,16,18,19], in the literature. After the critical analysis of results of our study, we hypothesize that augmentation, of an anatomically reduced and securely fixed femoral neck fracture, with a free fibular strut graft in fresh displaced Garden type 3 and type 4 fractures in young patients appears a promising option in bringing down the rates of NU and AVN. However, despite the promising results obtained, we accept limitations of our study that it was a small and non-randomized series and therefore more and more multicentric randomized trials of large number of patients are needed to validate our appraisal of fibular strut graft augmentation in the treatment of fresh Garden type 3 and type 4 fractures of neck of femur.

Conclusion

We conclude that free fibular strut grafting is quite worthy, inexpensive, easily procurable without any long-term

morbidity at the donor site, and may therefore be tried as an augmentation tool for union in fresh displaced Garden type 3 and type 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, and can be done by an average orthopaedic surgeon even at the district level hospitals if the facility of image intensifier is available.

Disclosure of Potential Conflicts of Interest

We, hereby, declare that we have no financial interest, direct or in direct in connection with the contents of this paper. We did not receive any financial grant from external or internal sources.

Ethical Standard Statement

All patients were duly informed about the research study and a written informed consent for their participation in the study was obtained.

We carried out all our procedures in accordance with Helsinki declaration.

Our study was cleared and approved by the Research Ethics Committee of our Institution.

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