Original Article

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Rate of Union and Complications, between Muscle Pedicle Bone Grafting and Free Fibular Grafting in Fractures of Neck of Femur: A Comparative study

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Abstract

Background: Fractures of the femoral neck always present a big challenge to surgeons, especially middle age group. In our country, they often present late with variable amount of neck absorption. Various treatment modalities like internal fixation with or without bone graft, various osteotomies, etc. are present.

Objectives: Our objective was to study and compare the rate of union and complications of two procedures, namely vascularized muscle pedicle bone grafting (MPBG) and free fibular grafting in fractures of neck of the femur.

Materials and Methods: This is a comparative retrospective and prospective study comprising 32 patients having fracture neck of femur of more than three weeks duration. One group (Group-A), comprised of 16 patients underwent neck reconstruction by tensor fascia lata or sartorius based muscle pedicle bone graft and iliac grafting when necessary followed by internal fixation through modified Smith Peterson approach. Another group (Group-B) comprises of 16 patients, who underwent internal fixation along with free fibular grafting through separate posterolateral approach to fibula. Internal fixation was done in all cases. This study uses Gupta's classification system for fracture neck of femur and harris hip score for functional outcome.

Results: Of Group-A patients there was an average delay of 5 months from injury to operation; all were of Gupta's 1 b or 2 bc category. Satisfactory union occurred in 14 cases (93%), delayed union in 26% cases and nonunion in one case (6%), with an average Harris hip score (HHS) of 75% at 9 months follow up. Of Group-B patients, average delay was seven weeks and all were 0 or 1b category. Here satisfactory union occurred in 13 cases (86%), delayed union in 14% cases and nonunion in two cases (13%). Average HHS at 9-month follow-up was 80.33%. Post-operative complications were greater in Group-A. Avascular necrosis was seen in one case in Group-B.

Conclusion: Here in our study, union rate is higher in MPBG patients than in fibular grafted ones, may be due to better neck reconstructions and revascularization whereas functional outcomes are better in fibular grafted patients.

Key words: Avascular necrosis, Fracture neck of femur, Free fibular grafting, Muscle pedicle bone grafting, Tensor fascia lata

INTRODUCTION

Fractures of the neck of femur always present a big challenge to surgeons especially in young and middle age group of patients. In our country, patients often present lately with a variable amount of neck absorption, which usually starts three weeks onwards.

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Various treatment modalities are presents for this type of fractures, like osteosynthesis, with or without bone graft, osteotomies, and hemi or total hip arthroplasties for advanced age groups. In young patients, osteosynthesis needs special surgical considerations such as anatomical reduction, secure internal fixation, and supplemented with free or muscle pedicle bone grafting (MPBG) to promote healing. Muscles used for MPBG are Sartorius, tensor fascia lata (TFL) and anterior fibers of gluteus medius anteriorly and quadratus femoris and posterior fibers of gluteus

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medius posteriorly. Free graft includes phemister-type tibial cortical graft, iliac crest, and free fibular graft.

Vascularity and viability of MPBG were shown to be preserved in animal experiments. Moreover, the superiority of vascularized graft over non vascularized ones was proved in animal experiments where almost all osteocytes died in the non vascularized graft while 70% of osteocytes in 88% cases of MPBG were preserved in comparison to the normal side.

Hence, Judet (1962),[1] utilized MPBG in the treatment of femoral neck fractures, but he did not publish the results. Meyers *et al.*[2] in 1974 reported encouraging results with this technique. He noted 1% of nonunion and 8% avascular necrosis (AVN) in cases where MPBG was done as compared to 20-30.8% nonunion and 7.3%-42.8% AVN when treated without MPBG (Parker and Pryor, 1973).[3]

In 1983, Baksi[4] reported encouraging results in post-traumatic avascular necrosis of the femoral head with the use of MPBG. Since un-united femoral neck fractures present special problems, some modifications of this technique, as described by Meyers were made and Baksi applied the evolved technique in a case series in 1986.[5] The technique comprised of freshening of the fracture site, decompression of the avascular femoral head by multiple drilling, reconstruction of absorbed femoral neck with free bone grafts and fixation of MPBG around the internal fixation screws (CHS) with a silk thread. Baksi had a non-union rate of 11%.

Osteotomy has been used to alter biomechanics at the fracturesite to promote healing, both with or without internal fixation, and in some cases with the addition of bone graft to helpstimulate bone healing.

The two main types of osteotomy used in these situations have been the medial displacementosteotomies, such as that employed by Mc-Murray[6] and the angulationosteotomy as employed in studies by Karla and An and.[7] The valgus angulation osteotomy is usually of the subtrochantericor intertrochanteric type. These have been used to convert the shearing forces at the fracturesite into compression forces, thereby improving union chances. In addition, the angulation osteotomy can correct rotationaland limb length discrepancies at the same time.

However, osteotomy has two major problems; shortening, limp, and a decreased range of movement, probablybecause of increased pressures on the femoral head leading todegenerative disease or osteonecrosis[8,9] and potential risks of non-union at the osteotomy site, althoughnot so common in literature.[10] Osteotomies have resulted in ratesof AVN ranging between 6% and 42% and a non-union rate between0% and 45%. Where measured by differing criteria, a "good" functional outcome has been recordedin 35-80% of the subject population*

Henderson[11] treated non-union of the femoral neck fracture by open reduction and free fibular grafting with POP hip Spica for 3 months. Nagi *et al.*[12,13] reviewed young patient treated by ORIF with one cancellous screw with free fibular graft and supplemented it with external immobilization using Thomas knee splint or a foam gutter splint or POP hip Spica and reported encouraging results. Nagi had non-union rate of 5%, and AVN 12%.

In modification of Nagi's technique, Gupta *et al.*[14] have successfully treated 25 cases of neglected fracture neck femur by closed reduction and internal fixation by three peripherally placed cannulated cancellous screws and centrally placed free fibular graft where union occurred in all cases.

In our study, we chose one vascularized i.e. MPBG and another nonvascularized procedure like free fibular grafting and our study is to compare the result of union, rate of avascular changes and complications.

MATERIALS AND METHODS

This comparative retrospective and prospective study was conducted in IPGMER and SSKM hospital, Kolkata from June 2009 to August 2010. We have included in our study patients attending outpatients department, emergency and follow-up clinic, <60 years of age, post traumatic fracture neck of femur more than three weeks duration and no avascular changes of femoral head at plain X-rays at the time of presentation. Patients aged more than 60 years; with comorbid medical condition and fracture neck of femur other than traumatic cause, like pathological fracture etc. or having radiological features of AVN, previous history of any surgery of affected hip and where acetabulum is pathologically affected by any cause, were excluded. This study was conducted on 32 patients after taking proper written informed consent and after obtaining ethical clearance. The cases were divided into two groups, 16 in each group. The first group (denoted as Group A) was treated by reconstruction of the femoral neck by MPBG and internal fixation and the second group (denoted as Group-B) underwent internal fixation and free fibular strut grafting.

Before the procedure, each patient was clinically and radiologically evaluated. We used Gupta's radiological classification system and functionally assessed both pre and post operatively by Harris hip score (HHS).

Technique of MPBG

Modified Smith-Petersen approach was used and we utilized TFL in ten cases and Sartorius based MPBG in five cases. A segment of the iliac crest 2.5 cm long and 2.5 cm broad was then osteotomized and retracted down keeping its attachment to the anterior fibers of the TFL or Sartorius as the case may be, intact. The muscle pedicle bone graft was so prepared that it gets its blood supply from superior gluteal artery and the ascending branch of lateral femoral circumflex artery. Bleeding from the raw surface of muscle pedicle bone graft was observed.

Next, the anterior capsule of the hip joint was opened following section of straight and reflected head of rectus femoris from the capsule. Under imaging, fracture was reduced and temporarily fixed with three guide wires in parallel relation. The bony portion of the MPBG was fixed in a slot, made at the anterosuperior subarticular margin of the femoral head close to the neck, with a 4 mm cancellous screw. We also impacted free iliac graft, when required, to reconstruct the femoral neck. Fracture was finally fixed with, 3 cannulated hip screws through previously placed guide wires. The cut margins of capsule and gluteus minimus muscle are then repaired to secure the graft. The wound is closed after hemostasis in layers over the suction drain. If needed subcutaneous adductor tenotomy was done. Postoperatively after the reduction of pain and discomfort, partial weight bearing with crutches was allowed which was gradually increased to full weight bearing after clinical and radiological evidences of satisfactory union.

Technique Used for Internal Fixation with Free Fibular Strut Grafting

We used standard closed reduction technique in thirteen patients and Lead better technique inflexion in three patients for internal fixation. Fracture was initially fixed with three parallel guide wires under imaging. Appropriately sized cannulated lag screws are then inserted in two of the guidewires. Selection of 3rd guide wire for fibula depends on the space available on anteroposterior and lateral views. In one patient, we had done (case no: 3) closed reduction internal fixation with pediatric sliding hip screw followed by fibular grafting for basicervical fracture of the neck of femur.

Middle third of the fibula, of appropriate length was harvested through separate standard posterolateral approach or by percutaneous method on the same leg. After drilling with a DHS reamer graft was introduced through the 3rd guide wire and impacted. After viewing final construct under imaging, wound was closed in layers. In the post-operative period, wound was inspected after 5 days and sutures removed after 12 days. After 3 weeks, toe-touching weight bearing, with crutches was started. Gradually, full weight bearing was advised after satisfactory maintenance of fixation and radiological evidence of union.

Evaluation of fracture healing was done by clinical, radiological, and functional assessment. All intra and postoperative complications like blood loss, infection, urinary tract infections, hip stiffness were accounted for. Non-union was defined as radiolucent gap existing between sclerosed bony ends after 6 months of surgery.

There is no universally accepted hip score. Different authors have used different hip score. In this study, Harris hip evaluation system (modified) was used to assess the functional outcome of two groups of patients.

Patient satisfaction as graded by the following way:-

- Excellent: Hip score: 90-100, Patient is very satisfied.
- Good: Hip score: 80-90, Patient is satisfied.
- Fair: Hip score: 70-80, Patient is satisfied, but not up to the mark.
- Poor: Hip score is <70, patient is not satisfied.

RESULTS

All the cases were posttraumatic fractures of neck of the femur. In Group-A, nine cases were Type 2 bc and seven cases were Type 1 b and in Group-B ten cases were Type 1 b and six cases were Type 0 according to Gupta's classification system. There were no cases of death and one case in each group was lost to follow-up. The duration of follow-up varied from minimum 6 months to maximum 5 year 6 months, averaging at 15 months. Average time elapsed from injury to operation were 5 months in-Group A and 7 weeks in-Group B. In-Group A an average age of the patients were 38 years with twelve males and four female patients. In-Group B, average age was 40 years with ten males and six female patients. All patients were from lower socioeconomic strata. Majority of Group A patients were healthy, one case had hypertension, and one case had generalized debility. Whereas in-Group B two patients had hypertension and one patient had diabetes. Case no 2 of the same group had contralateral tibial shaft fracture. Preoperative average Harris hip score was 30 in Group A and 18 in-group B, whereas nine months post-operative was 75% in-Group A and 80.33% in Group B.

Satisfactory union was achieved in fourteen cases in-Group A (93%), and thirteen cases in Group B (86%). Average time taken for union was 6 months in group A and 4 months in Group B.

Average operative time was 2 h in group-A patients compared to 1.5 h in group-B patients. Average postoperative stay in hospital was 4 weeks in MPBG patients compared to2 weeks

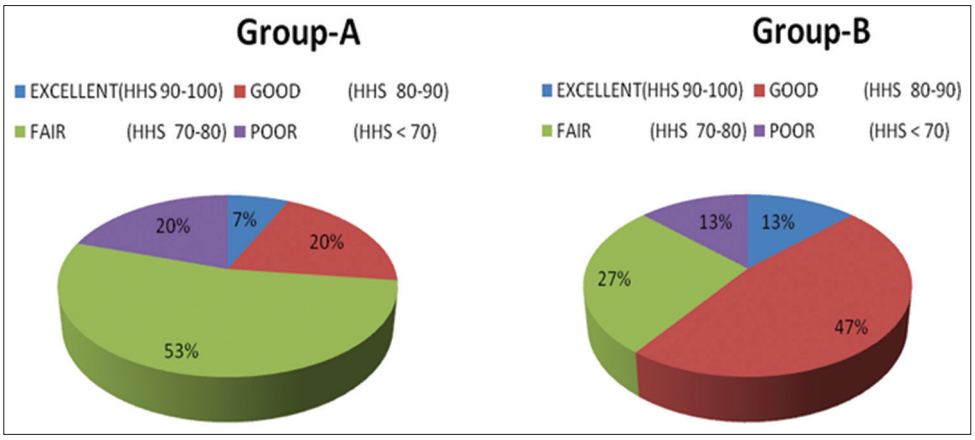

Figure 1: Differential Distribution of outcome of the result of HHS in group A and group B patients

in Group-B. In Group-A, one patient had non-union (6.6%), delayed union occurred in three cases (26%). In-Group B two patients (case no 11,12) had non-union (13%) for which hemiarthroplasty was done later on. Delayed union occurred in two patients (13%). One patient (case no 7 in gr-B) had avascular change in the femoral head, i.e. segmental collapse, sclerosis in plain radiography with painful hip movements. In-group A no patients had AVN change. In group A eight patients had stiffness of hip (case nos. 2, 3, 7, 9, 12, 11, 13, 14) and all patients had limp of which two patients (Case nos. 5, 10) had painful limp. In group B, three patients had hip stiffness (case nos. 9, 10, 13) and eight patients had slight limp (case nos. 3, 5, 7, 9, 11, 12, 13,15) of which two patients had painful limp (case nos. 7, 11). In-group A, four patients (Case no 5, 6, 9, 11) had superficial wound infection all of which subsequently healed with antibiotics and dressing. In-group B, two patients had superficial skin infection (case no 6, 9) of whom one had infection over fibular graft donor site (case no 95). In-group A, two had a deep infection (Case no 2, 10) and recovered after repeated debridement, dressing and prolonged antibiotics. In-group B, no patients had a deep infection.

There were no cases of any neuromuscular complications in any group. In-group A, five patients had increased blood loss per-operatively (case nos. 1, 5,9,14,15). Pre-operative blood investigations were normal in both groups. Two cases in group B and four cases in Group A were given post-operative blood transfusion. There were no cases of thromboembolic episode or heterotopic ossification in any of our study group.

We have found urinary tract infection in two patients in-Group B (Case nos. 6, 9), and three patients in Group A (case nos. 5, 10, 14).

DISCUSSION

Fractures of neck of femur have inherent problem of variable amount of neck absorption resulting in increased shearing stress at fracture gap even after rigid fixation along with microvascular compromise that causes implant loosening, nonunion and avascular changes and thus treatment is always challenging.

We included only posttraumatic fractures of the neck of femur of more than three weeks duration as neck absorption usually starts after that and excluded fractures having radiological AVN changes as this would cause confounding factor. We deliberately excluded patients aged more than 60 years because they have more comorbidities and complications influencing the results. In our series, mean delay from injury to operation was 7 weeks in group-A and five months in Group-B. The various reasons for the delay included late presentation, non-compliance of the patient for surgery, low socio-economic status of the patients, illiteracy, hospital bed unavailability, delay in getting surgical fitness of patients. etc.

HHS was adopted because this is more reproducible and consists of easy day-to-day activities or procedures and with less intra or inter observer variability.

We used modified Smith Petersen approach in our study Group-A. This approach retains the advantages of the anterior iliofemoral approach, but exposes the trochanteric region laterally; this makes aligning a fracture or osteotomy of the femoral neck and inserting screws or nails under direct vision easier. It gives a continuous exposure of the anterior aspect of the hip from the acetabular labrum to the base of the trochanter. We have also used this approach because of choice of muscle pedicle, having patients in the supine position and less damaging effect on medial epiphyseal vessels than in the posterior approach.

We chose free fibular autograft in our study Group B because of low demand, minimal donor site morbidity as

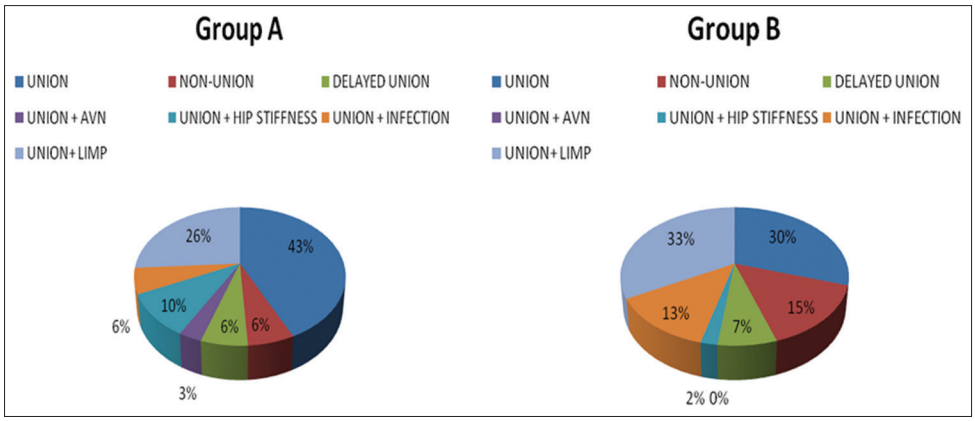

Figure 2: Differential distribution of complications in Group A and Group B patients

percutaneous technique was practiced in the majority of patients. Moreover being cortical, it provides structural support against shearing forces, rotational stability for its trephine shape, and a scaffold for bone healing.

Overall union rate in our study group B was 86%, including delayed union 14%, comparable to that of Nagi *et al.* (90%), Sandhu *et al.* (88.03%),[15] and Lecroy *et al.* (90.90%),[16] but lower than that of Huang[17] and Hou (100%). Varus union occurred in two patients. Decreased union rate in-Group B in respect to Group A was found to be due to inadequate reconstruction of the femoral neck. Varus union may have been due to late collapse as a consequence of instability of internal fixation due to deficient neck. One patient (Case no 7) had avascular change of the femoral head in Group B, with implant migration and persistent painful stiff hip. Avascular changes might be due to initial vascular insult. In this patient implant, migration occurred due to early weight bearing and probably collapse of fracture site. We had to remove the implant after bony union. This again might have been the same reason for screw migration in one patient. Hence, fibular graft is not adequate in those cases where a good amount of neck absorption is present.

Baksi and Meyer popularized muscle pedicle bone grafting. We used three parallel CHS that gives most stable fixation. Meyers' *et al.* and Baksi have preferred fixation with modified Hagie pins in their studies. We have used TFL and Sartorius based MPBG because they are technically less demanding, avoiding prone position, lower morbidity, and also TFL or Sartorius are stronger structures than quadratus graft. Moreover, we faced lower rate of posteromedial comminution in fracture neck of femur. Moreover, posterior approach might lead to damage of medial epiphyseal vessels, which are the only existing blood, supply of fractured femoral neck. We fixed TFL MPBG segment with cancellous screws in most of the cases and used sutures in few cases. Screws were used for better fixation of the graft. Graft dislodgement was not encountered in any patient. It was easy to fix the graft with screw and fixation was better. Meyers' in his series also preferred graft fixation with a screw while Baksi preferred circumferential silk suture for the fixation of the graft. In some cases, cancellous chip graft from ASIS was used for better reconstruction and also for easy exposure. MPBG was used to supplement blood supply to the femoral head to prevent AVN and non-union. No case of avascular necrosis was seen in group A, probably due to successful revascularization procedure.

Table 1: Age and sex wise distribution of patients in Group A

Age	Sex		Side	
	Male	Female	Right	Left
25-36	4	0	3	1
37-48	5	3	5	3
49-60	3	1	3	1

Table 2: Age and sex wise distribution of patients in Group B

Age	Sex		Side	
	Male	Female	Right	Left
25-36	3	1	3	1
37-48	4	3	6	2
49-60	3	2	3	1

Table 3: HHS at nine months follow-up in Group A and in Group B patients

HHS	Group-A	Group-B
0-40	0	0
41-50	0	0
51-60	1	1
61-70	2	1
71-80	8	4
81-90	3	7
91-100	1	2
Average	75	80.33

HHS: Harris hip score

Regarding functional outcome, according to HHS, better results were seen in fibular grafted patients (80%) compared to MPBG group (75%), the cause might have been due to, increased duration of pain, decreased range of motion, longer immobilization, hip stiffness, increased rate of infection in muscle pedicle transferred group.

Restriction in hip movement and hip stiffness was greater in Group A (33%) than in Group B patients (20%). The cause is mainly due to more tissue handling, leading to fibrosis, infection, longer period of immobilization, etc.

Totally, 4 patients had superficial and 2 patients had a deep infection in Group A due to extensive dissection and tissue handling. All of these recovered with repeated debridement, lavage, dressings, and use of antibiotics. In Group B, only 2 patients (13%) had a superficial infection probably due to smaller incision and less tissue handling.

Per-operative amount of blood loss and operating time was more in Group-A than in Group B patients due to more tissue handling and meticulous dissection required in MPBG cases.

Postoperative hospital stay in group A was longer (mean-4 weeks), in comparison to 2 weeks in group B, probably due to increased pain, infection, etc.

Increased rate of urinary tract infection was noted in group A than in group B due to increased use of urinary catheter in Group A patients. Minor morbidities like ankle swelling, leg ache after long walks were observed in Group A patients. Donor site morbidity like tingling or paresthesia on skin over the operative site in Group B due to lateral femoral cutaneous nerve damage during dissection.

In this study, duration of injury and femoral neck absorption were more in group A cases than in fibular grafted patients. In our country, people squat and sit cross legged very often and a large part of the population is manual laborers and patients often present late. In this setup, total hip replacement is not the ideal solution due to poor facilities, poverty, illiteracy, etc. In this scenario, the femoral head salvage is the primary aim of the surgeon, especially in younger patients. From the previous discussion, it is apparent that rigid fixation along with some femoral neck reconstruction is necessary, in old/neglected fractures of the neck of femur.

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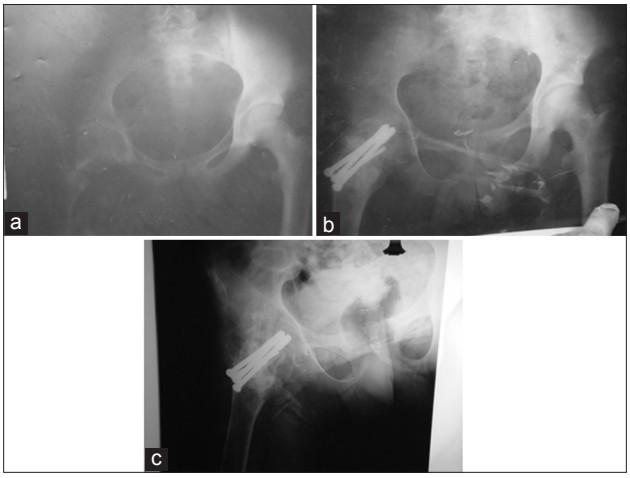
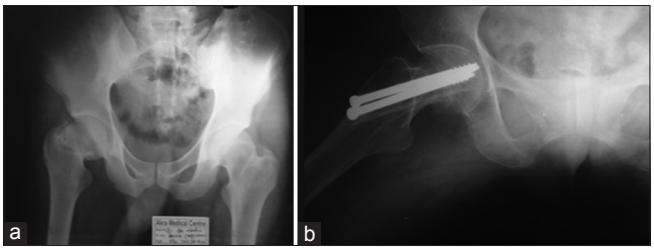
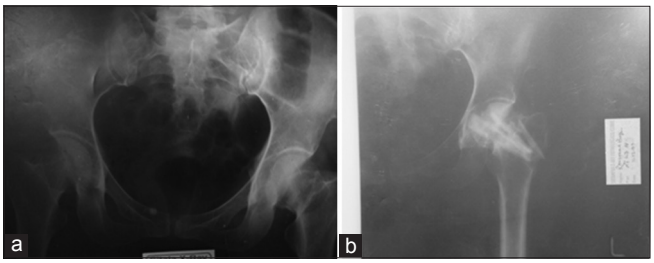
ILLUSTRATION



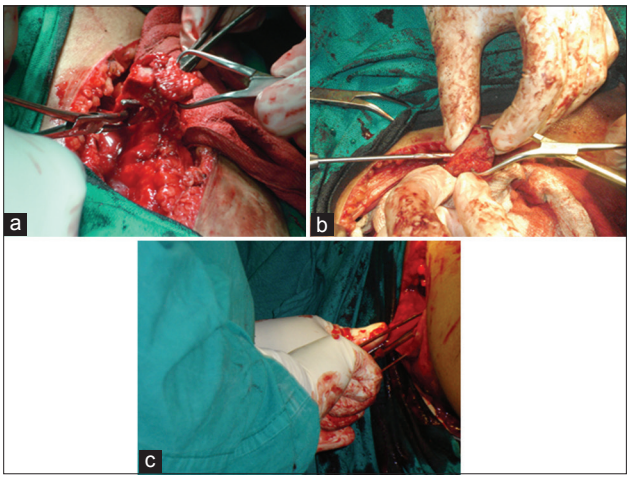
1. Pre and postoperative tomogram of a TFL MPBG patient(Case no 1) of group-A (a) Pre-operative, (b)At 6 months, (b) Union at 9 months



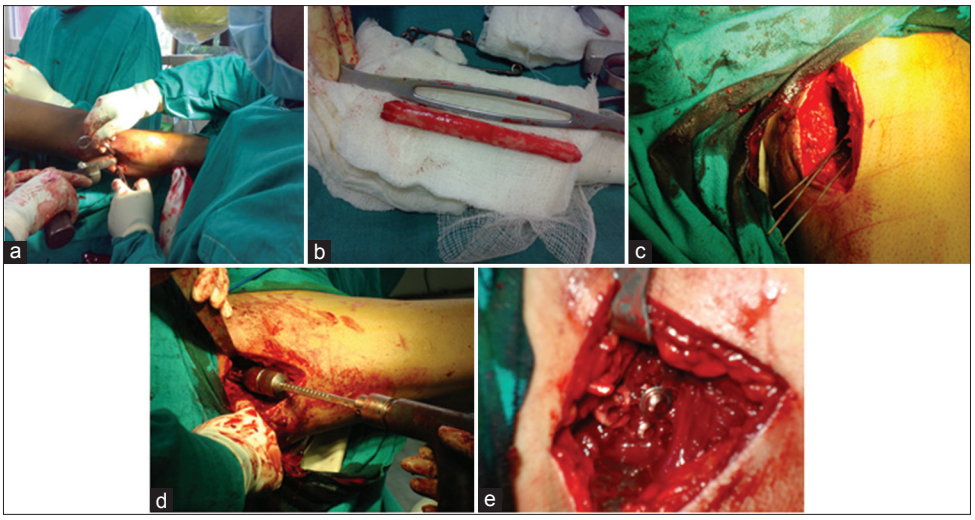
2. Pre and postoperative tomogram of a fibular grafted patient in group B(Case no 8): (a) Pre operation, (b) AVN At 16 months



3. Pre and postoperative tomograms of a fibular grafted patient with AVN (a) Pre operation, (b) AVN At 16 months



4. Photographs of TFL MPBG preparation in case no 1 of group A (a) TFL MPBG secured, (b) Graft placement, (c) Internal fixation



5. Photographs showing percutaneous removal of fibula for graft preparation and internal fixation with CHS and fibular graft in case no 1 of Group B (a)Removal of fibula, (b)Guide wire insertion (c) Reaming (d)Int fixation complete

6. Clinical photographs of fibular grafted patients showing different movements of the hip joint in group B: (a)Sitting cross leg, (b) Squatting, (c)Standing, (d)Hip flexion

7. Clinical photographs of muscle pedicle bone grafted patients, (a)Flexion, (b) Abduction, (c)Sitting cross leg