Original Article

Augmented osteosynthesis with tensor fascia latae muscle pedicle bone grafting in neglected femoral neck fracture

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Abstract

Background: Neglected intracapsular femoral neck fracture in young patients may fail to unite because of the excessive shearing strain at the fracture site and it is a surgical challenge to any orthopedic surgeon. The problem is compounded by resorption of the femoral neck and avascular necrosis (AVN) of femoral head. There is no satisfactory solution available in the management of femoral neck fracture as far as the union of the fracture and AVN of femoral head are concerned. Muscle pedicle bone grafting has been advocated to provide additional blood supply to the femoral head. We report a retrospective analysis of 48 cases of neglected femoral neck fracture treated by internal fixation and tensor fascia latae based muscle pedicle bone grafting.

Materials and Methods: 48 patients with femoral neck fractures with age varied from 20 to 53 years (average age 32.9 years) with male to female ratio of 2:1 were enrolled. All fractures were more than 3 weeks old with mean delay being 86 days (22–150 days). Open reduction and internal fixation along with tensor fascia latae muscle pedicle bone grafting was done in all cases. It was supplemented by multiple drilling and cortico-cancellous bone grafting. Fracture fixation was done with three parallel 6.5-mm AO cannulated cancellous lag screws and the graft fixed with a 4-mm cancellous screw to provide a secure fixation. During the followup period of 2-6.8 years (average 4.4 years) the results were assessed clinically by modified Harris hip scoring system and radiologically by the evidence of signs of fracture union.

Results: Union was achieved in 41/48 (85.41%) cases which were followed for an average period of 4.4 years (2–6.8 years) with good functional results and ability to squat and sit cross-legged. Results were assessed according to modified Harris Hip Scoring system and found to be excellent in 19, good in 22, fair in 5, and poor in 2 patients. Complications were nonunion, (*n*=3) avascular necrosis (*n*=2), and coxa vara deformity (*n*=2).

Conclusion: Internal fixation with muscle pedicle bone grafting is a suitable option to secure union in neglected femoral neck fractures in physiologically active patients with late presentation.

Key words: Neglected femoral neck fracture, osteosynthesis, tensor fascia latae muscle pedicle bone grafting

Introduction

The femoral neck fracture report either after a delay or no/improper treatment in developing countries because of poverty, ignorance or lack of tertiary care facilities.[1,2] Neglected intracapsular femoral neck fracture in young patients may fail to unite because of the excessive shearing strain at the fracture site and it is a surgical challenge to any orthopedic surgeon. The problem is compounded by resorption of the femoral neck and avascular necrosis (AVN) of femoral head. There is no satisfactory solution available in the management of femoral neck fracture as far as the union of the fracture and AVN of femoral head are concerned.[3-8]

In 1962, the autogenous muscle pedicle graft based on the quadratus femoris muscle was used for the first time, advocated by Judet[9] and popularized by Meyers *et al*.[10] Later, fresh autogenous cancellous iliac bone chips combined with muscle pedicle bone grafting were reported with good outcome.[11-15]

In Meyer procedure, the pediculated bone graft is taken from quadratus femoris insertion and placed posteriorly to

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the femoral neck, and thus may compromise the important vascular supply (posterior subsynovial retinacular artery, which runs along the posterior aspect of the base of the neck).[16] Other vascularized pedicular bone grafts used for fracture neck of femur[17] include sartorius, tensor fascia latae,[18] gluteus medius,[19] ilio psoas,[20] and vascularized iliac bone grafting.[21]

We report a retrospective analysis of 48 patients of neglected femoral neck fracture treated by open reduction and tensor fascia latae based muscle pedicle bone grafting technique.

Materials and Methods

Forty-eight consecutive cases of neglected femoral neck fractures were treated by open reduction, internal fixation, and muscle pedicle bone grafting between April 2005 and December 2009. Age of the patients varied from 20 to 53 years (mean age 32.9 years). Thirty-two patients were males and 16 were females. All patients with a displaced femoral neck fracture with late presentation (more than 3 weeks old) were included in the study. Patients with pathological fractures, associated systemic pathology like ankylosing spondylitis, inability to walk (other than the femoral neck fracture), or with an inability to cooperate in the postoperative program were excluded from the study. The mean delay in presentation to the department after sustaining fracture was 86 days (range 22–150 days). All patients were followed for at least 2 years after the index procedure. The mean followup duration was 4.4 years (range 2–6.8 years). Road traffic accident was the commonest mode of trauma (n=28), followed by fall from height (n=20). The right side was involved in 26 patients. Five patients presented with associated injuries [simple fracture both bone forearm (n=1), simple fracture humerus (n=1), compound fracture both bones leg (n=1), fracture shaft of the femur (n=1), and ipsilateral comminuted supracondylar fracture femur (n=1)].

All patients had an antero-posterior radiograph of the hip in 15° internal rotation to assess the amount of neck resorption, apart from the standard A–P and lateral radiographs. Thirty-five patients presented with more then 3 weeks of injury having preoperative shortening with an average of 2.2 cm (range 1.7–2.8 cm) due to some degree of femoral neck absorption. They were kept in below knee skin traction while waiting for surgery. Radiographic evidence of AVN was assessed according to the stages described by Ficat.[22]

Operative procedure

The patients were operated under regional anesthesia in supine position on a fracture table. The anterior Smith-Peterson approach was used in all cases [Figure 1A(a)]. Lateral cutaneous nerve of thigh was carefully isolated and protected [Figure 1A(b)]. The tensor fascia latae muscle which originates from outer border of iliac crest was identified. After retracting gluteus medius and rectus femoris, the anterior capsule of hip joint was exposed. An inverted "T" incision was made over capsule and the fracture was visualized directly [Figure 1A(c) and 1B(a)]. The fracture surfaces are cleared of fibrous tissue and any tags of periosteum. The sclerosed fracture edges were freshened till bleeding and multiple drill holes were made in the femoral head to ensure thorough decompression of the avascular bone. Invariably, in majority of patients with late presentation, the neck is absorbed, so the fracture is reduced in valgus within the limits of Garden's alignment index and cortico-cancellous bone grafting harvested from iliac crest is used to reconstruct the neck length. After separating the deep fascia and splitting the vastus lateralis, the base of the trochanter and upper shaft of femur were exposed. Three 6.5 mm AO cannulated cancellous screws were inserted parallel to each other over guide wire in an inverted triangle configuration [Figure 1B(b)]. Final positions of the screws were checked under image intensifier both in A–P and lateral views, which should be placed in more or less central position of head and neck of femur [Figure 1B(c)].

The rectangular graft was then marked out at the origin of the tensor fascia latae in the iliac crest with a small osteotome. Then, with straight and curved osteotome, a graft of 1 cm depth, 1 cm width, and about 3 cm length was gently cut out [Figure 1C(a)]. The graft was mobilized and transferred downward and medially. One end of the graft was trimmed and a slot was made in the femoral head and anterior aspect of the neck across the fracture site. The graft was then placed into this slot and after impaction, it was firmly secured with a 4-mm cancellous lag screw and washer [Figures 1C(b and c)]. The wound was closed in layers over vacuum suction drain.

The mean blood loss measured intra-operatively is 173.9 ml (varied from 150 to 200 ml).

The patients were allowed to sit up on bed after 24 hours; first postoperative dressing and drain removal was done after 48–72 hours. They were encouraged to start active quadriceps exercises and non–weight-bearing exercises of hip and knee joints. Non–weight-bearing ambulation by walker was started by fourth or fifth postoperative day. Partial weight bearing was allowed gradually depending on the status of union which was assessed radiologically by serial radiographs when the fracture gap started disappearing and clinically when the patient did not complain of any pain while weight bearing. Full

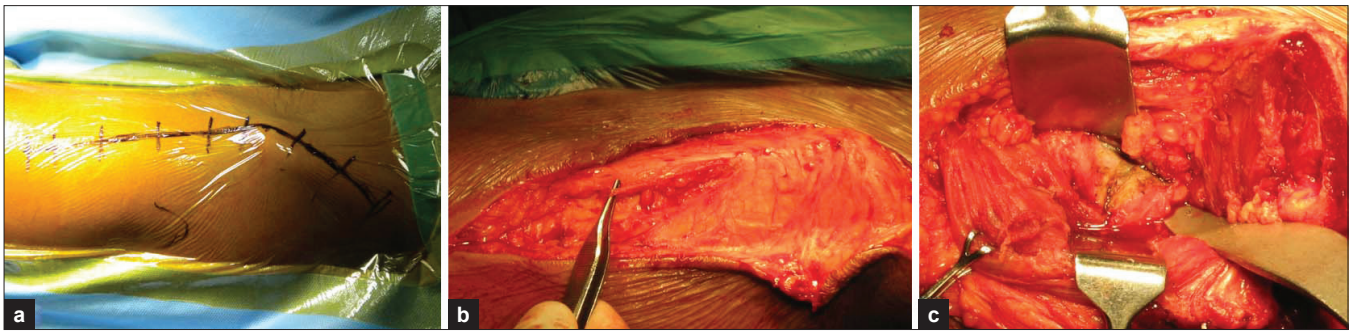

Figure 1A: Peroperative photograph showing (a) Marking of skin incision, (b) Isolation of lateral cutaneous nerve of thigh, (c) Exposure of capsule

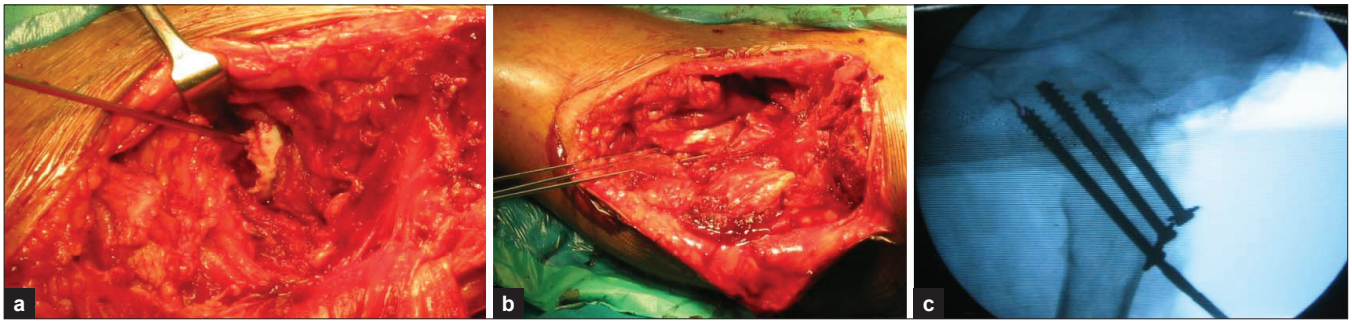

Figure 1B: Peroperative photograph showing (a) Reduction of fracture, (b) Passing of guide wires, (c) Passing of cannulated screw over guide wire checked under Image Intensifier control

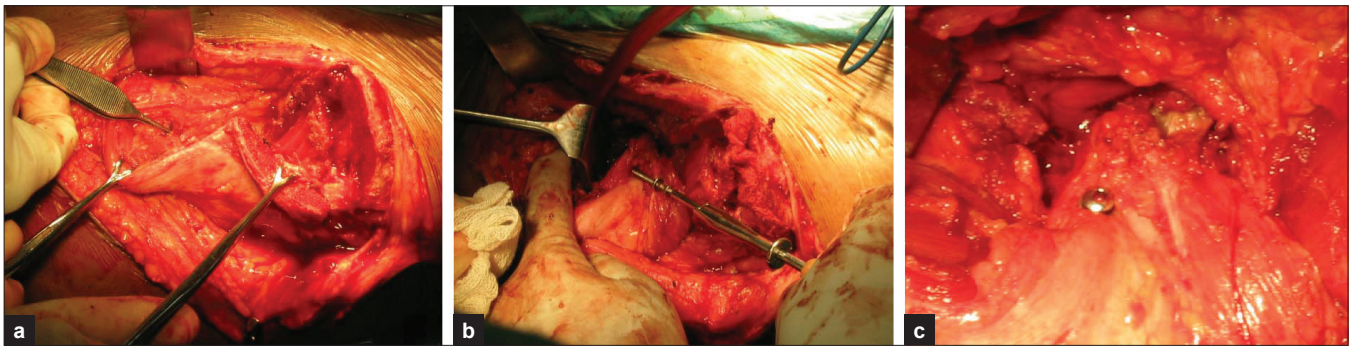

Figure 1C: Peroperative photographs showing (a) Tensor fascia latae muscle pedicle graft harvested from iliac crest, (b) Mobilization and graft placement over anterior surface of femoral neck. (c) Final position of graft

weight bearing was allowed only after full osseous union, on an average of 5.5 months after the operation (range 3–8 months). The patients were clinicoradiologically followed up on clinical examination, range of hip movement, pain on weight bearing, limp and leg length discrepancy were assessed. Radiological assessment was done by A–P and lateral view X-rays for the evidence of union and AVN at 3 weeks, 6 weeks, 3 months, 6 months, 1 year, and then every 6 months till 2 years, and after that every year.

Results

The average followup is 4.4 years (range 2 - 6.8 years). Bony union was defined as radiologically bony continuity across the fracture gap and clinically absence of pain on weight bearing. It was observed in 41 out of 48 patients [Figures 2 a–e] giving a union rate of about 85.41% [Table 1].

At the end of 2 years, the results were analyzed according to modified Harris hip scoring system, and they were found to be excellent in 19 [Figures 3A and B], good in 22 [Figures 4 and 5], fair in 5, and poor in 2 patients [Table 2].

Nonunion occurred in three patients due to loss of internal fixation after early weight bearing. They did not want any further intervention as they could manage their activities of daily living very well and needed a cane only during prolonged walking. Four patients demonstrated increased density of lucency in the femoral head (Grade 2 of Ficat) preoperatively. At the final followup, only one patient had progression with irregularity of femoral head (Grade 3) and the remaining three

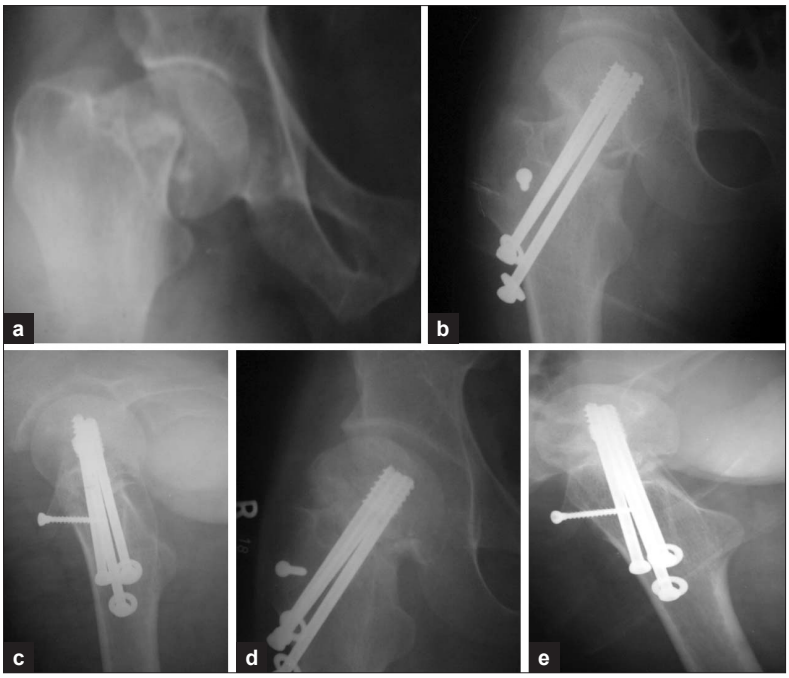

Figure 2: (a) X-ray right hip joint (anteroposterior view) showing ununited femoral neck fracture (b) postoperative X-ray (anteroposterior view) showing valgoid reduction, screws in position (c) postoperative x-ray (lateral view) showing position of screws (d) 2.3 years followup (anteroposterior view) showing fracture union (e) 2.3 years followup (lateral view) showing fracture union

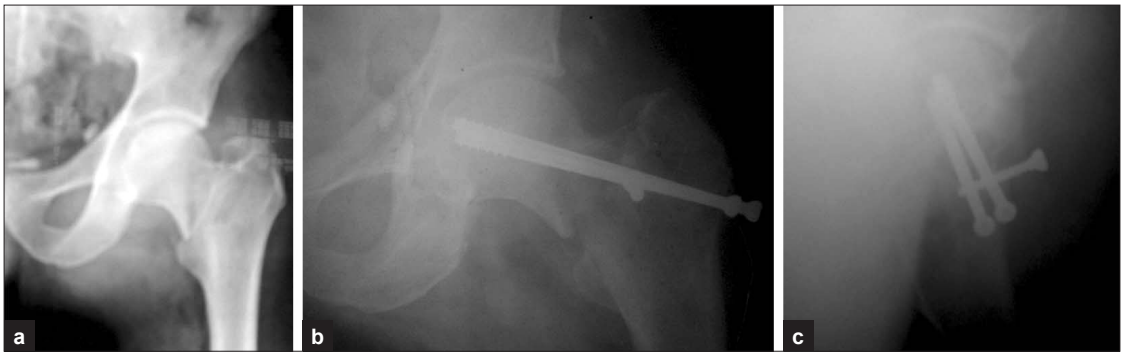

Figure 3A: X-ray of the left hip joint (a) Preoperative (anteroposterior view) showing ununited femoral neck fracture. (b and c) Postoperative x-ray (anteroposterior and lateral view) showing position of screws

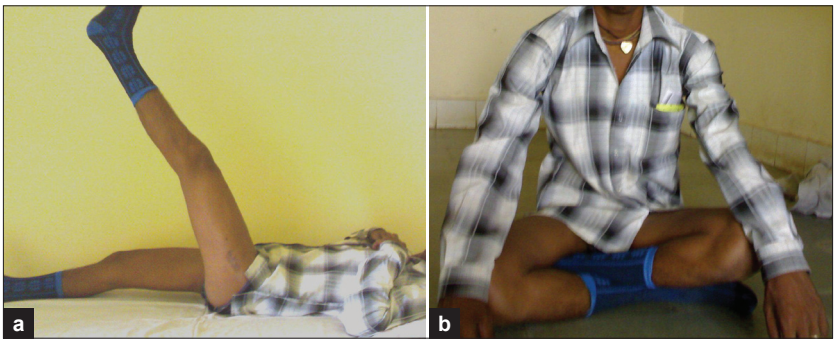

Figure 3B: Clinical photographs of same patient after 5 months followup showing (a) patient able to do active straight leg raising (b) cross legged sitting

patients revascularized radiographically without collapse. Coxa vara, was seen in two hips. The fractures united and followed for 3 years showed no evidence of AVN.

Leg length discrepancy was noted ($n=35$) in the group of patients with significant resorption of the femoral neck, who sought medical attention late.

Table 1: Clinical details of patients

Case	Age (years)	Sex	Side	Mode of affected injury	Mean period of delay (days)	Followup (years)	Shortening		Time of union (months)	Results
							Pre-op (cm)	Post-op (cm)		
1	34	F	L	RTA	46	4.5	2.3	1.0	4.5	United
2	26	M	R	Fall	27	2.7			3.2	United
3	39	M	R	Fall	54	6.3	2.3	1.0	4.6	United
4	45	F	L	Fall	62	5.9	2.5	0.7	5.2	United
5	27	F	R	RTA	37	3.1	2.1	0.5	3.5	United
6	33	M	R	Fall	24	3.8			3.1	United
7	23	M	L	Fall	22	6.2			3.0	United
8	36	F	R	Fall	34	4.7			3.4	United
9	32	F	R	RTA	37	5.5	2.0	0.5	3.7	United
10	21	M	L	Fall	35	2.8			3.0	United
11	28	M	L	Fall	42	6.4	2.1	0.5	3.3	United
12	36	M	L	RTA	55	6.6	2.1	0.5	4.9	United
13	27	F	R	Fall	65	3.5	2.7	1.0	-	AVN
14	32	M	R	RTA	47	5.8	2.2	0.5	4.3	United
15	39	F	L	Fall	51	6.1	2.1	0.7	4.7	United
16	27	M	L	Fall	56	6.5	2.1	0.6	3.2	United
17	35	M	R	Fall	90	4.9	2.9	1.7	-	Nonunion
18	20	M	L	RTA	25	3.6			3.0	United
19	32	F	R	Fall	37	3.7	2.1	0.5	3.9	United
20	22	F	R	RTA	84	3.3	2.4	0.8	7.2	United
21	37	M	R	Fall	42	2.9	2.5	1.5	-	Nonunion
22	23	M	L	Fall	81	3.4	2.3	0.7	8.0	United
23	26	M	R	RTA	70	2.6	2.3	0.5	3.3	United
24	36	M	R	Fall	75	5.7	2.2	0.6	4.9	United
25	33	F	L	RTA	50	4.6	2.1	0.5	4.7	United
26	44	M	R	Fall	37	3.2			4.5	United
27	25	M	R	Fall	42	2.4	2.2	0.8	3.2	United
28	51	M	R	Fall	68	5.1	2.1	1.7	4.7	Coxa vara
29	27	F	L	Fall	56	3.7	2.2	1.0	3.2	United
30	39	M	L	RTA	30	4.3			4.1	United
31	29	M	L	RTA	54	3.4	2.1	0.8	3.3	United
32	43	M	R	Fall	39	6.7	2.3	0.5	4.6	United
33	32	F	R	RTA	47	4.3	2.2	0.5	4.6	United
34	25	F	L	Fall	150	5.6	2.9	2.0	-	Nonunion
35	37	M	L	RTA	98	2.1	2.5	1.0	4.2	United
36	46	M	R	RTA	45	5.3	2.2	0.7	3.9	United
37	26	M	R	Fall	118	4.2	2.3	1.0	6.2	United
38	34	M	R	Fall	27	2.3			3.4	United
39	22	M	L	RTA	45	6.0	1.7	0.5	3.1	United
40	43	F	R	RTA	31	4.8			3.7	United
41	29	F	L	Fall	56	5.2	2.2	0.5	3.3	United
42	53	M	R	RTA	41	4.0	2.1	1.0	-	AVN
43	33	M	R	Fall	35	5.4			3.9	United
44	37	F	R	Fall	42	3.9	2.0	1.0	4.2	United
45	28	M	L	RTA	25	6.8			3.2	United
46	39	M	L	Fall	53	2.5	2.2	1.0	4.3	United
47	42	M	R	RTA	120	3.0	2.8	1.7	7.5	Coxa vara
48	30	M	L	RTA	32	4.4			3.2	United

*RTA - Road traffic accident, cm - Centimeter

In spite of reconstruction of the femoral neck using cortico-cancellous iliac crest graft in 30 patients, there was 0.5–1 cm shortening and in three patients in whom the fracture remained ununited, there was 1.5–2 cm shortening [Table 3].

Superficial infection occurred in three cases which healed within 2 weeks by regular dressing and broad-spectrum antibiotic therapy. Only one patient developed deep-seated infection and the implants were removed. Later, he developed AVN [Figure 6].

Fracture of the pedicle graft occurred in two cases early in this series probably because the graft was too thin or cracked while it was being removed but eventually the fracture united.

Discussion

Treatment of ununited femoral neck of fracture is a challenging to treating surgeon. Massie[23] demonstrated a direct relationship between delay of treatment and incidence of nonunion and AVN after a displaced femoral neck fracture. Hirata *et al*.[24] used dynamic magnetic resonance imaging (MRI) in 36 cases of femoral neck fractures within 48 h of injury and found absence of femoral head perfusion in 19 patients. In this group of 19 patients, osteonecrosis developed in 10 and nonunion developed in 5 patients.

There is a consensus opinion that in physiologically active patients, we should try to preserve the head of the femur.

Table 2: Modified Harris hip score

Age (years)	Grade according to modified Harris hip score			
	Excellent	Good	Fair	Poor
20-30	09	10	-	01
31-40	09	08	02	01
41-50	01	03	02	-
51-60	00	01	01	-
Total	19	22	05	02

Anatomical reduction, impaction, and rigid internal fixation are essential in treating femoral neck fractures.

Muscle pedicle bone grafting has been advocated along with rigid internal fixation to prevent nonunion and AVN of the femoral head. In neglected fractures, multiple drilling of the femoral head decompresses the necrotic bone and encourages the growth of vascular granulation tissue. Packing free cortico-cancellous bone grafts between the fracture surfaces helps to restore femoral neck length. Placement of muscle pedicle bone graft acted as a viable vascular inlay graft, encouraging osteosynthesis and revascularization of the femoral head.

Judet[9] tried quadratus femoris muscle pedicle bone graft in dogs and later used the same technique in human beings. Several authors have used the quadratus femoris muscle based bone graft in the management of displaced, delayed subcapital fractures of fracture neck femur and AVN. The rate of union as reported by Meyer's was 89% (121/136) and the incidence of AVN was 8% only. Baksi[12] achieved 82% (46/56) union rate using a muscle pedicle graft. He reported encouraging results with multiple drilling and muscle pedicle bone grafting in the treatment of various stages of osteonecrosis of femoral head.[26] Gupta reported 100% (20/20) union in ununited fractures of femoral neck by muscle pedicle periosteal grafting.[27]

Table 3: Complications

Age (yrs)	Gender		Mean period of delay (weeks)	Mean time of Union (months)	NU	AVN	Coxa vara	Shortening	
	M	F						0.5-1cm	>1cm
20-30	12	08	11.5	4.5	01	01	-	13	01
31-40	14	06	10.5	4.8	02	-	-	13	02
41-50	04	02	7.5	5.6	-	-	01	03	02
51-60	02	00	7.0	5.8	-	01	01	01	-
Total	32	16			03	02	02	30	05

AVN - Avascular necrosis, NU - Nonunion, cm - Centimeter

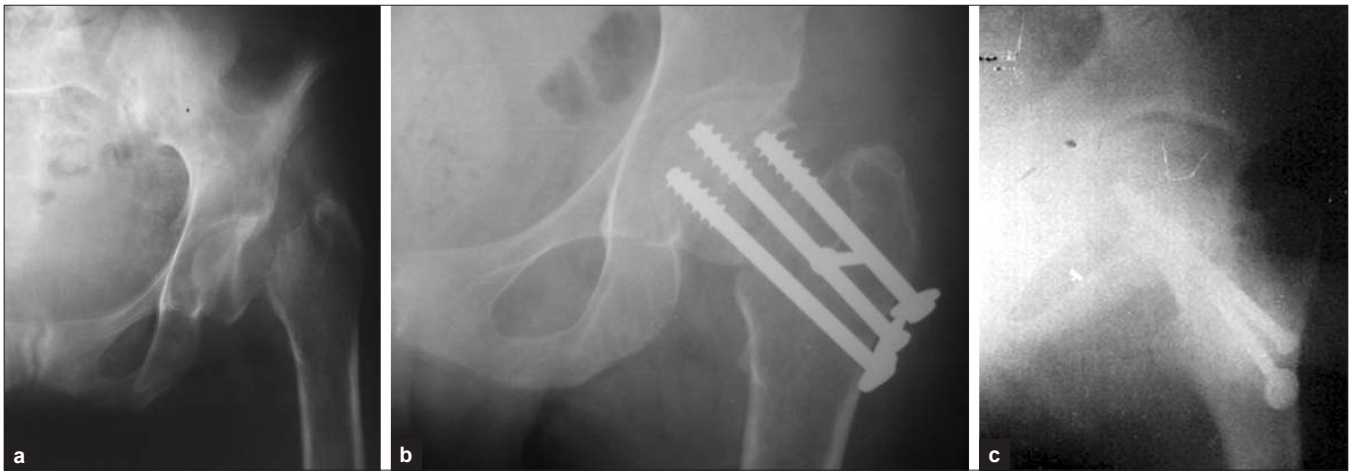

Figure 4: X-ray left hip joint anteroposterior view showing (a) 81 days old ununited femoral neck fracture (b) immediate postoperative X-ray (c) 2.5 years fowlloup

Table 4: Details of previous series of neglected femoral neck fractures

Author(s)	Number of cases	Number with delay >3 weeks	Method of treatment	AVN	NU	Comment
Meyers *et al.*[11]	136	-	ORIF+Quadratus Femoris muscle Pedicle graft	05	15	89% Union
Baksi[26]	56	56	ORIF+Meyers muscle pedicle graft	02	05	82% union rate
Hou *et al.*[21]	05	05	ORIF+Pedicled iliac bone graft	0	0	Union with excellent result
Leung and Shen[20]	15	04	ORIF+Pedicled iliac bone graft	0	0	Excellent result
Vallamshetla *et al.*[15]	42	42	ORIF+Meyers muscle pedicle graft	01	06	86% Union rate
Present series	48	48	ORIF+TFL Muscle pedicle graft	02	03	85.41% Union rate

ORIF-Open reduction internal fixation, TFL- Tensor fascia latae, AVN-Avascular necrosis, NU- Nonunion

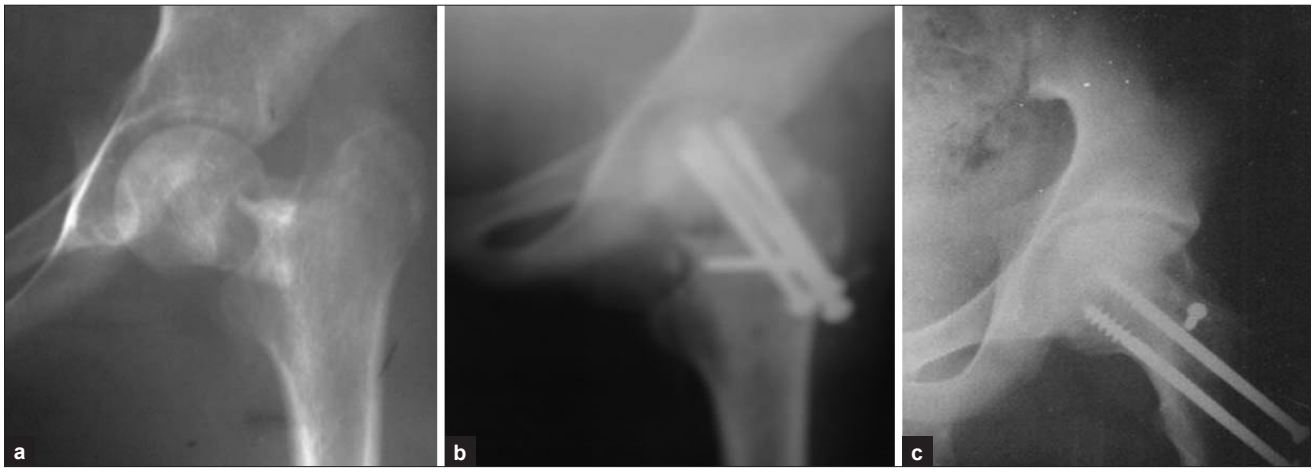

Figure 5: X-ray left hip joint anteroposterior view showing (a) 45 days old ununited femoral neck fracture (b) immediate postoperative X-ray (c) 2.6 years followup

Meyers'[11] technique of open reduction and internal fixation using quardratus femoris based MPBG may endanger the medial circumflex femoral artery. We have used tensor fascia latae based muscle pedicle bone graft to reduce further vascular compromise. Compared to Meyers' technique (where patients are placed in prone position), in this procedure, the patient is placed in supine position over the fracture table and also cancellous bone chips harvested from iliac crest are used to fill up any gap at the fracture site before internal fixation to increase the stability of the fracture reduction.

The results are quite comparable with the results of various series [Table 4]. It shows that in patients with ununited fractures of the femoral neck, preservation of the femoral head is achievable. Results achieved were 85.41% (41/48) bony union, five failures, and two coxa vara deformities. These results suggest that a marked reduction in the incidence of late segmental collapse and AVN of the femoral head can be achieved by muscle pedicle bone grafting technique. I believe that this graft stimulates early and complete revascularization of the head of the femur by providing an additional source of blood supply.

Whilst Dickson[28] has suggested valgus osteotomy and cancellous bone grafting. Negi *et al.*[1] have used fibular autograft after open reduction and internal fixation of the neglected fracture of femoral neck. Fibular autografting provides structural support to the femoral neck during fracture healing, but the disadvantage of this option is donor site morbidity and lack of additional blood supply to the femoral head. Free vascularized pedicle graft[29] has been used with excellent results, but it requires microvascular expertise. We reported very low rate of AVN using muscle pedicle grafting, with fracture union whilst maintaining the vascularity of the femoral head.

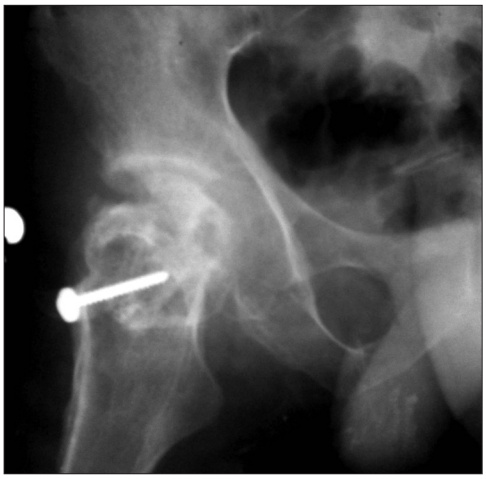

Figure 6: X-ray right hip joint anteroposterior view showing AVN following infection

It would have been ideal if the patient had a preoperative and postoperative MRI to demonstrate the vascularity of the femoral head.[30] Such investigations are not routinely performed in our institute and would add considerable cost to the patient and hospital.

The favorable results can be achieved by anatomical reduction, cortico-cancellous bone grafting to reconstruct femoral neck, internal fixation with cancellous screws, and augmentation with muscle pedicle bone grafting in neglected fracture neck of femur.

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