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Original Article

Evaluation of osteosynthesis with dual fibular bone grafting for neglected femoral neck fractures[☆]

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ABSTRACT

Background: Femoral neck fractures in young adults is an unsolved problem and neglected femoral neck fractures presents more challenge to the orthopaedics surgeon if femoral head salvage is attempted. We reviewed the operative results of neglected femoral neck fractures in young adults with fixation with dual fibular bone grafting Purpose of study was evaluation of epidemiological, clinical, functional, rehabilitative outcome and complications in such patients.

Methods: Twentyeight patients in age group 18–50 years were operated having fracture neck femur by dual fibular bone grafting in the Department of Orthopaedics, S.N. Medical College, Agra in (May 2005–February 2008) and divided into two groups. Group A: comprised of 8 patients treated by dual fibular bone grafting alone and Group B: comprised of 18 patients treated by dual fibular bone grafting with single cancellous hip screw.

Results: All the patients of the present series were having neglected intracapsular fracture, neck femur which were treated by dual fibular bone grafting with or without cancellous hip screw fixation. Majority of the patients had good to fair result according to Larson method with average time of union 16 weeks. All patients had useful range of movement at hip. Satisfactory union was achieved in all patients except two.

Conclusion: Double bone grafting is a simple and cost effective modality of treatment for late femoral neck fracture with good results. It is a stable and biological method of fixation with preservation of natural femoral head with fewer complications.

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1. Introduction

Fractures of femoral neck have been notoriously called the unsolved fracture¹ as far as its treatment and results are concerned. These fractures occur in an environment where limited and unprotected blood supply to the femoral head, the intracapsular location of the fracture, strong muscle forces across the hip-joint, flow of synovial fluid and osteoporosis with severe trabecular atrophy of the femoral neck inhibit fracture healing. Non-union and osteonecrosis of the femoral head are the two main complications of this fracture especially if the patient presents late.

Femoral neck fracture in young adults occur with high energy trauma² and is associated with high incidences of non-union and osteonecrosis of femoral head. Damany et al³ in a meta-analysis of 18 articles on fracture neck femur of 564 patients 15–50 years old, showed an overall non-union rate of 8.9%. They found that with open reduction the rate of non-union increased to 11.2% compared with 4.7% for fractures treated with closed reduction. The overall rate of osteonecrosis in their study was 23%.

In under developed countries these fractures are often seen after a delay and improper treatment because of poverty, ignorance, and lack of medical facilities. There have been many studies regarding management of neglected neck fractures in young adults. Most aim at preservation of natural femoral head while reconstructive procedures such as arthroplasty being reserved as secondary or salvage procedures.

Treatment options for such fractures range from internal fixation alone or in conjugation with either osteotomy or bone grafting (vascularised or nonvascularised). Various internal fixation devices have been used such as cancellous hip screws, dynamic hip screws, 135° angled blade plate, and free fibular struts. Cannulated cancellous screws are the most common form of internal fixation used in such patients. Internal fixation with screws and bone grafting has been used by various authors with varying results. Both vascularised as well as nonvascularised bone grafts have been used. McMurray's osteotomy, excision hip (Girdlestone and Bachelor procedure) were very popular as salvage procedures before the advent of replacement arthroplasty. However they may still be useful in developing countries such as India, suiting their lifestyle, living conditions and habits even today as patient can sit, squat and walk without support though with some limp shortening and instability.

Fibular bone graft has certain advantages as it prevents the subchondral collapse, acts as a biological implant and as a channel for revascularization. Because of its trephine shape it acts on the principle of Smith Peterson Nail and thus adds to the stability of fracture reduction. The main aim of the study was to insure stable painless and mobile hip and to see effect of double fibular graft with or without cancellous hips screws on union and to assess rate of non-union, avascular necrosis and other complications in such cases.

2. Material and methods

In this study cases were selected from the patients attending the out-patients Department of Orthopaedics and the Emergency Department of S.N. Medical College & Hospital, Agra. This study was conducted between May 2005–and February 2008. Each patient was subjected to detailed clinical and radiological examination along with routine pathological investigations. Informed consent was taken. The patients who could be operated within three weeks of injury were labelled as fresh cases and others as old cases.

2.1. Inclusion criteria

- 1) Age of the patient – after fusion of epiphysis to 50 years.
- 2) Duration of fracture – more than 3 weeks at the time of operation.

2.2. Exclusion criteria

- 1) Uncooperative patients in the postoperative regimen because of psychoses, mental retardation, Parkinsonism, or cerebrovascular accident with residual hemiplegia and spasticity.
- 2) Unsuitable neighbouring skin, infected abrasions, blebs, burn or bed sores.
- 3) Poor anaesthetic and general risk patients.
- 4) Complete reabsorption of neck, partial reabsorption was not considered a contraindication

Complete resorption of neck was taken as exclusion criteria based on Indian orthopaedics association white paper⁴ which recommends osteosynthesis should not be attempted in such cases as they have high chances of failure.

Table 1 – Results based on anatomical type of fracture.

Results	Subcapital				Transcervical				Basal			
	Group A		Group B		Group A		Group B		Group A		Group B	
	No	%	No	%	No	%	No	%	No	%	No	%
Good	0	0	2	50	4	66.67	8	80	0	0	3	75
Fair	0	0	1	25	2	33.33	2	20	1	100	1	25
Poor	1	100	1	25	0	0	0	0	0	0	0	0
Total	1	100	4	100	6	100	10	100	01	100	04	100

Table 2a – Range of movement of hip-joint, results and complications (group A).

Cases	Extension	Flexion	Abduction	Adduction	External rotation	Internal rotation	Pain	Shortening	Radiological – features		
									Osseous union	Feature of AVN	Cox avara (degree)
1	15°	110°	45°	35°	45°	35°	No pain	–	3.5 Months	None	None
2	10°	100°	35°	25°	35°	30°	Pain only with weight bearing	0.5	3 Months	None	None
3	15°	100°	30°	30°	45°	30°	No pain	–	4 Months	None	None
4	20°	110°	40°	40°	40°	40°	No pain	–	3 Months	None	None
5	15°	90°	45°	35°	45°	40°	No pain	–	4.5 Months	None	None
6	10°	90°	35°	25°	40°	40°	No pain	0.5	4 Months	AVN with no surgical collapse	8°
7	5°	80°	30°	25°	30°	25°	Pain with fatigue	0.5	Non-union	None	None
8	20°	100°	35°	35°	30°	30°	No pain	–	5.5 Months	None	None

A total of 28 patients of fracture neck femur were operated 18 males and 8 females with mean age 37.4 years (range 18–50 years) and divided into two groups depending upon the size of femoral neck.

Group A: double fibular bone grafting without cancellous hip screw fixation. This was done in those patient in which femoral neck was narrow so that it could accommodate only two fibular struts. This group comprised of 8 patients.

Group B: double fibular bone grafting with single cancellous hip screw fixation. Comprised of 20 patients, two were lost during follow-up.

Under spinal or epidural anaesthesia all the fractures were reduced by closed method either by Whitman or Leadbetter technique and affected limb was kept in abduction and internal rotation on fracture table. Reduction was checked under fluoroscopy. Proximal femur was exposed by 8–10 cm

Table 2b – Range of movement of hip-joint, results and complications (group B).

Cases	Extension	Flexion	Abduction	Adduction	External rotation	Internal rotation	Pain	Shortening	Radiological – features		
									Osseous union	Feature of AVN	Cox avara (degree)
1	5°	100°	45°	35°	40°	35°	No pain	–	3 Months	None	None
2	10°	100°	40°	40°	35°	35°	No pain	–	4.5 Months	None	None
3	10°	100°	35°	30°	35°	25°	Pain with weight bearing	0.5 cm	3 Months	None	5°
4	10°	90°	45°	35°	35°	40°	No pain	–	3 Months	None	None
5	15°	110°	40°	40°	40°	40°	No pain	–	4 Months	None	None
6	10°	90°	35°	25°	35°	30°	Pain with weight bearing	–	5 Months	AVN with no surgical collapse	None
7	15°	110°	45°	40°	45°	35°	No pain	–	4 Months	None	None
8	5°	90°	35°	30°	30°	30°	Pain with fatigue	0.5 cm	3.5 Months	None	None
9	10°	100°	40°	40°	40°	40°	No pain	–	4 Months	None	None
10	15°	110°	45°	45°	45°	40°	No pain	–	5 Months	None	None
11	15°	100°	45°	40°	40°	35°	No pain	–	3 Months	None	None
12	5°	70°	30°	20°	25°	20°	No pain	1.0 cm	3 Months	None	10°
13	10°	100°	30°	30°	40°	30°	No pain	0.5 cm	3.5 Months	None	None
14	15°	120°	45°	40°	35°	40°	No pain	–	3.5 Months	None	None
15	10°	110°	40°	40°	30°	35°	No pain	–	3.5 Months	None	None
16	10°	90°	40°	35°	35°	30°	Pain with fatigue	–	Non-union	None	None
17	15°	110°	45°	45°	40°	25°	No pain	0.5 cm	3 Months	None	5°
18	15°	120°	40°	40°	40°	30°	No pain	–	3.5 Months	None	5°

Fig. 1 – Harvesting fibula 15–16 cm length.

lateral longitudinal incision. Depending upon the size of femoral neck three or two guide wires were passed in femoral neck up to subchondral area of femoral head and their length was measured. Inferior guide wire was passed closer to calcar under fluoroscopic guidance and other guide wires were passed superior to it leaving at least 3–5 mm space in superior portion of neck to prevent cut through of the graft and to achieve secure purchase. If neck was narrow so that only two guide wires can be passed than the second guide wire was passed in the centre of femoral head. In the meantime second team did fibular graft harvesting from the ipsilateral side. Approximately 15–16 cm of fibula was taken out leaving its proximal and distal ends and divided into two halves. Size of the graft was chosen according to the measured length of guide wire. Multiple drill holes were made with 2.5 mm drill

Fig. 2 – Fibular graft cut in two half approximately 8 cm each.

Fig. 3 – Making drill holes in fibula for incorporation of graft.

Fig. 4 – Insertion of guide wires.

Fig. 5 – Position of guide wire in C-arm AP view.

Fig. 6 – Position of guide wire in C-arm lateral view.

bit at regular intervals on two surfaces and interosseous border was left intact. Multiple drill holes increased the chances of bony ingrowth into the head and neck and hasten early incorporation of the graft. Reaming for the fibular graft was done with distal end of triple reamer (8 mm) and graft was trimmed and inserted over the guide wire. Then graft was gently hammered with Smith Petersen nail introducer under fluoroscopic guidance and fixation of fracture neck femur was done with or without cancellous hip screw. Cancellous screw was inserted over inferior guide wire after drilling with 4.5 mm cannulated drill bit. Suction drain was inserted and skin was closed in layers.

Fig. 7 – Reaming done with distal part of triple reamer for fibular graft insertion.

Fig. 8 – Reaming under C-arm guidance.

Follow-up of patients was done postoperatively at monthly intervals for 3 months and then after an interval of two months by clinical and radiological assessment. Active in bed hip range of motion exercises were allowed from next post-operative day. During the follow-up period partial weight bearing with walker and then with stick was allowed at 4–8 weeks. Full weight bearing was allowed after 12 weeks depending upon the clinical and radiological evidence of union as well as when the hip was painless. Obliteration of the fracture site with trabecular bridging was taken as the evidence of union.

Functional evaluation was done by Larson's method at six months.

3. Results

Results were assessed by following Larson's method of functional assessment. According to this method we evaluated the

Fig. 9 – Fibula impacted.

Fig. 10 – Impacted fibula as seen in image intensifier.

patients in terms of freedom from pain, function, gait, freedom from deformity and range of motion at hip.

62.5% cases of group A and 55.6% cases of group B showed good results, while 25% cases of group A and 38.9% cases of group B showed fair results. 12.5% cases of group A and 5.6% cases of group B showed poor results. Patients were staged preoperatively on basis of Sandhu predictive classification⁵ which is based on size of proximal fragment, gap b/w proximal & distal fragment indicating amount of neck absorption, smoothening out of fracture surfaces and condition of the head of femur.

All our patients were of grade 1 or 2 according to Sandhu classification.

The majorities of the patients were having transcervical fracture neck femur from anatomical point of view and were operated in between 3 and 5 weeks of injury. On radiography, 37.5% cases of group A and 27.8% cases of group B were having posterior comminution. Preoperative absorption of neck was present in 25% cases of group A and in 22.2% cases of group B. The duration of surgery in majority of the patients was in between 60 and 90 min (mean 72 min).

Average time to union was 3.92 months (range 3–5.5 months) in group A and 3.64 months in group B (range 3–5 months). Postoperative shortening was present in 37.5% cases of group A and 27.8% cases of group B ranging from 0.5 cm to 1 cm. In this study, non-union was seen in 12.5% cases of group A and 5.6% cases of group B. Osteonecrosis of femoral head was present in 1 case (12.5%) of group A and 1 case (5.6%) of group B but there was no segmental collapse in any of the two patient. There was 1 case of graft fracture postoperatively in both group A and group B due to early weight bearing by the patient against advice (Tables 1 and 2(a, b)) (Operative figures – Figs. 1–11).

4. Discussion

Fracture neck of femur continues to be a problem fracture from the point of view of its management. Fresh Intracapsular neck fractures in young adults is called a vascular emergency if viability of femoral head is considered and literature recommends early reduction and internal fixation of such fractures if femoral head has to be salvaged preferably within 6–12 h.⁵ In younger patients there is priority to preserve the natural femoral head in contrast to older population in which arthroplasty is now a well accepted treatment with good long term functional outcome.

Fig. 11 – Final radiograph after impaction of both fibula and 1 screw.

Fig. 12 – Preoperative radiograph.

In cases of neglected neck fractures in young adults the incidence of complications like avascular necrosis of head of femur is reported to remain as high as 15–33% and that of non-union is 10–30%.⁶ The femoral neck fracture is probably the fracture for which there exists the larger number of methods of osteosynthesis. In the literature various treatment methods have been described to preserve the natural femoral head in neglected fracture neck femur in young adult population. Main among them are internal fixation alone or internal fixation with osteotomy or bone grafting.

When the fracture neck of the femur is of more than 3 weeks duration, internal fixation alone has a very high failure rate. Internal fixation has to be combined with some type of

bone graft or osteotomy particularly in young patients below the age of 50 years (or 55 years) in whom it is desirable to preserve the joint.^{7,8}

Osteotomy has been used to alter biomechanics at the fracture site to promote healing. Several types of osteotomy have been described in literature such as medial displacement osteotomy (McMurrays)⁹ or angulation osteotomies.¹⁰ However, osteotomy has its associated problems such as, shortening, limp, decreased range of movement, increased risk of osteonecrosis and potential risk of non-union.

Stewart and Wells¹¹ in a series of 100 patients treated with osteotomy and internal fixation reported high rate of non-union (46%) including at the osteotomy site.

Fig. 13 – Immediate postoperative radiograph.

Fig. 14 – 24-month postoperative radiograph.

Lifeso and Young¹² felt that valgus osteotomy gave acceptable results but concluded that non-union in young adults was difficult to treat they reported non-union in 3 and osteonecrosis in 2 out of 28 cases.

Various types of bone grafts have also been used for such fractures. Vascularised grafts include muscle pedicle or vascular pedicle grafts while non-vascularised grafts include Phemister-type cortical tibial grafts and free fibular strut

Fig. 15 – Clinical photographs.

Fig. 16 – Clinical photographs (continued...).

grafts. Meyers et al¹³ in a series of 32 patients treated by ORIF with muscle pedicle graft reported 40% non-union in delayed and neglected fractures. Baksi¹⁴ in a series of 56 patients of ununited femoral neck fractures treated by internal fixation and muscle pedicle bone grafting reported satisfactory union in 42 (75%) and non-union in 5 cases.

Vascularised pedicle grafts using either the iliac crest or the fibula have shown excellent results with union rates of 91%–100% in small series.^{15,16} Vascularised free fibular graft has also been reported.^{17,18} These grafts have improved the rate of union of fracture particularly if the treatment is delayed beyond 3 weeks or if closed reduction is not

Fig. 17 – Preoperative radiograph.

Fig. 18 – Immediate postoperative radiograph.

anatomical. The functional results after union are quite satisfactory and lasting in very high percentage of cases. However, this technique is highly technical and requires microsurgical facilities and experience.

Free fibular grafting has been widely studied as a method to introduce both structural support and induce osteogenesis in a neglected femoral neck fracture. The results with this procedure have given non-union rates between 0% and 17% and AVN rates of 0%–33%.¹⁹ Nagi^{20,21} et al have reported good results with open reduction and internal fixation combined with free single fibular graft. Nagi et al in a study on 40 patients

treated with open reduction, internal fixation and fibular autografting for neglected fracture of the femoral neck reported excellent Hip function in seven patients, good in 21 and fair in seven and reported successful outcome in 87.5%. They reported non-union in 2 cases (5%) and osteonecrosis of femoral head in 5 cases (12.5%). Goyal et al²² in a series of 15 patient treated by single fibular graft and two cannulated hip screw reported union in 14 cases. They reported good result in 11 and satisfactory result in 2 patients.

The idea of biological fixation by twin fibular graft was put forward by Yadav.²³ In a study on 150 patients with fracture

Fig. 19 – 15-month postoperative radiograph.

Fig. 20 – Clinical photographs.

neck femur he showed a total of 88% had excellent to fair results, non-union in 17 and osteonecrosis in 14 cases.

In our series of osteosynthesis with double fibular bone grafting, majority of the patient were male (18) because they are more out going one and thus risk of sustaining injury is also greater in them. In our series on the basis of anatomical location 1 case in group A and 4 cases in group B were of subcapital type, 6 cases in group A and 10 cases in group B

were of transcervical type and 1 case in group A and 4 cases in group B were of basal type.

In the subcapital type 50% cases of group B scored good 25% cases of group B scored fair and 25% patient of group B and 100% case of group A (1 case) scored poor result. In the transcervical type 66.67% cases of group A and 80% cases of group B scored good and 33.33% cases of group A and 20% cases of group B scored fair. There was no poor result in this

Fig. 21 – Clinical photographs (continued...).

type of fracture. In the basal type 75% cases of group B scored good, while 100% cases of group A (1 case) and 25% of group B scored fair. So our study concluded that transcervical and basal type of fractures have a good prognosis in comparison to subcapital type though small sample size was our limitation.

In our series overall 87.5% of patient of group A showed good to fair results and 94% of patient of group B showed good to fair result. Series by Nagi et al²¹ showed 87.5% successful results while Yadav²³ reported 88% excellent to fair result. Thus our study showed comparable results with other similar studies.

In this study, non-union was seen in 12.5% cases of group A and 5.6% cases of group B. incidences of non-union reported by Meyer et al was 40% which was much higher than our results, while incidences of non-union reported in other similar studies by Baksi (8.9%), Nagi (5%) and Yadav (11.3%) closely resemble our incidence.

Avascular necrosis of femoral head was present in 1 case (12.5%) of group A and 1 case (5.6%) of group B. Incidences of osteonecrosis as reported by other studies Lifeso and Young was 7% Nagi et al (12.5%) and Yadav (9.3%) matches our incidence.

There was 1 case of graft fracture postoperatively in both group A and group B due to early weight bearing by the patient against advice. Both these cases later on developed non-union and were successfully treated by uncemented total hip replacement.

5. Conclusion

Dual fibular bone grafting with or without hip screw fixation is a simple and cost effective procedure for late femoral neck fractures in young adults with good results. Trephine shape of fibula gives added rotational stability. Drill holes in the fibula helps in the early incorporation of graft and also acts as a channel for revascularization at the fracture site. The fibula is easy to harvest and, provided that sufficient care is taken, leads to minimal morbidity of the donor site. The subchondral placement of the bony graft in avascular or osteopenic femoral heads may minimise structural collapse until revascularisation takes place. Cancellous screw placed through the calcar may increase the stability of the construct and provide added structural support until fibula gets incorporated. Chances of non-union are negligible. It gives a very good chance to save the natural femoral head in the acetabulum. Patients is having good functional results so that he is comfortable in his daily routine i.e. can sit cross legged and squat without or with minimal problems and this is specially valuable in Indian scenario where squatting and cross legged sitting are part of routine and day today activities. Later on if needed, this can be converted in to total hip replacement without much difficulty (Patient 1, 40/male, 4-week-old Fracture Neck Femur Right – Figs. 12–16 and Patient 2, 38/male, 5-week-old Fracture Neck Femur Left – Figs. 17–21).

Conflicts of interest

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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