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Dr. Sumit Kumar
Assistant Professor,
Department of Orthopaedics,
Pt. B.D. Sharma PGIMS,
Rohtak, Haryana, India

Dr. Sahil Arora
Assistant Professor,
Department of Orthopaedics,
Pt. B.D. Sharma PGIMS,
Rohtak, Haryana, India

Dr. NK Magu
Ex. Senior Professor,
Department of Orthopaedics,
Pt. B.D. Sharma PGIMS,
Rohtak, Haryana, India

Dr. Jagannath Desai
Assistant Professor,
Department of Orthopaedics,
KIMS, Koppal, Karnataka,
India

Correspondence
Dr. Sumit Kumar
Assistant Professor,
Department of Orthopaedics,
Pt. B.D. Sharma PGIMS,
Rohtak, Haryana, India

Long term clinico-radiological outcome of osteosynthesis in patients with femoral neck fracture: A retrospective study

Dr. Sumit Kumar, Dr. Sahil Arora, Dr. NK Magu and Dr. Jagannath Desai

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Abstract
Introduction: Fracture of the neck of femur continues to be one of the major orthopaedic injuries. It occurs in elderly patients with osteoporosis or in young patients suffering high energy trauma.
Aims and Objectives: To evaluate long term clinico-radiological outcome of osteosynthesis in patients with femoral neck fracture.
Material and Methods: Fifty patients of femoral neck fracture who underwent osteosynthesis with lag screw fixation or with valgus intertrochanteric osteotomy were studied. The patients were divided into 2 groups; Group-I (n=16) comprised of patients in whom osteosynthesis with lag screws was done and Group-II (n=34) patients had undergone valgus intertrochanteric osteotomy.
Results: In Group-I at an average follow up of 41.8 weeks no patient had non-union or AVN, all heads were viable, 6.25% had OA hip & intraarticular implant penetration, 93.7% had Harris hip score from good to excellent, d'Aubigne & Postel score from good to very good & SF-36 score below 10 whereas at an average follow up of 142.37 weeks 6.25% had non-union, 75% heads were viable, 25% had AVN & OA hip, 6.25% had intraarticular implant penetration, 75% had Harris hip score from good to excellent, d'Aubigne & Postel score from good to very good & SF-36 score below 10. In Group-II at an average follow up of 55.44 weeks 2.94% had non-union, 94.12% heads were viable, 5.88% had AVN, 8.82% had OA hip, no intraarticular implant penetration, 88.23% had Harris hip score from good to excellent, 91.17% had d'Aubigne & Postel score from good to very good & 79.41% had SF-36 score below 10 whereas at an average follow up of 159.3 weeks 2.94% had non-union, 82.36% heads were viable, 17.64% had AVN, 41.17% had OA hip, 2.94% had intraarticular implant penetration, 73.53% had Harris hip score from good to excellent, 72.22% had d'Aubigne & Postel score from good to very good & 70.58% had SF-36 score below 10.
Conclusion: Rate of union was found to be better in patients managed with valgus intertrochanteric osteotomy than with lag screw osteosynthesis. The incidence of avascular necrosis seems to be higher in patients of group-I as compared to group-II patients. The overall clinical & radiological outcomes in both groups became worse on long term follow up.

Keywords: Clinico-radiological outcome, osteosynthesis, patients, femoral neck fracture

Introduction
Fracture of the neck of femur is regarded as the "unsolved fracture" [1]. It has been divided into three groups on the basis of anatomical location i.e. sub capital, transcervical and basicervical. The sub capital fracture is the most notorious out of the three because of the major risk of developing avascular necrosis (AVN) of femoral head. Fracture neck of femur may occur at any age but old people especially elderly women predominate but the incidence has increased in younger individuals as well due to increase in high energy trauma.
Management of displaced fracture neck of femur presents a great challenge to the orthopaedic surgeons. Various methods of treatment in these fractures comprise of internal fixation, hemiarthroplasty, total hip arthroplasty. Internal fixation methods include 6.5mm non cannulated or 7.0mm cannulated cancellous lag screw fixation, dynamic hip screws, 120^0 angled plate fixation, valgus osteotomy, locking proximal femoral plate, proximal femoral nail, Dynamic Martin Screw (DMS) and internal fixation combined with muscle pedicle bone

Grafting [2]. However, non union and AVN are known complications of sub capital fractures of neck. There is high incidence of AVN and non union (30.1%) in Garden type III and IV (displaced) fractures [3]. Most common reason for failure of internal fixation in the patients with fracture neck of femur is inadequate reduction, followed closely by inadequate fixation [4]. Besides this, posterior comminution and osteoporosis are other reasons for failure of internal fixation.

Internal fixation results in fewer postoperative complications, a shorter hospital stay and reduced cost of treatment, but adequate fixation is not always achieved. This increases the rate of failed osteosynthesis (21%) and non union (20-35%) subjecting the patient to revision surgery in 20%-36% cases [5, 6].

For a successful osteosynthesis, the femoral head should be viable, with the size of the proximal fragment to be of atleast 2.5 cm length. With a higher risk of non union (20-35%) in elderly, AVN (10-20%) fractures around implant (1-2%) and increased rate of reoperation 19% (in undisplaced fractures) and 33% (in displaced fractures), the current temptation has been to perform hemiarthroplasty or total hip arthroplasty [7].

Various methods of internal fixation have been used for femoral neck fractures and various complications have been found. The precarious blood supply of femoral head along with other contributing factors predisposes femoral neck fracture to a high risk of future complications like non-union, AVN, secondary osteoarthritis (OA) & others. It is important not only to internally fix these fractures but also to follow up the patients for long as many of the complications develop long after surgery. Therefore, we present this retrospective study to evaluate the long term clinico-radiological outcome of osteosynthesis in patients with femoral neck fracture.

Material and methods

The present retrospective study was conducted on 50 patients with intracapsular femoral neck fractures, who had been operated in Orthopaedics department of Pt. B.D. Sharma PGIMS, Rohtak in last 20 years.

Inclusion criteria: Adult patients with intra capsular femoral neck fracture who had been operated for osteosynthesis.

Exclusion criteria-patients operated for failed osteosynthesis were excluded from the study.

The patients were contacted either by postal communication, by telephone or by personal messages for latest follow up, referred here as present study. The clinical & radiological records available in the department were also used for the study, referred here as the previous study.

The following radiographs were taken:

i. Anteroposterior view of the pelvis including both hips
ii. Anteroposterior view of the affected hip, in 15 degree internal rotation.
iii. Frog-leg view of the affected hip

All the patients were subjected to thorough clinical examination for assessment of range of movements, any limp, pain, limb length discrepancy or any deformity. The functional evaluation was done by various scores i.e. modified Harris Hip Score, criteria of d'Aubigne and Postel, SF-36 score [8-10] Non-union was defined radiologically as failure of fixation, loss of reduction or persistence of a visible fracture line at a minimum of 6 months after surgery [11]. AVN was classified radiologically as per Ficat and Arlet classification [12]. Presence of OA was assessed radiologically as per Matta's criteria [13].

Statistical analysis

At the end of the study the data was collected and analysed by using Student t-test and Chi-square analysis.

Observations

The present study is an extension of the study of patients of femoral neck fractures operated in the past during the mentioned period. The patients were divided in 2 groups; Group-I of 16 patients in whom osteosynthesis with lag screws was done; and Group-II of 34 patients who had undergone valgus intertrochanteric osteotomy. Five patients of group-II had died between this period therefore we used the previously available data of these patients for the purpose of study. The patients were further evaluated by calling them for their latest follow up, referred here as the present study. The clinic-radiological & functional outcomes were compared at an average follow up of 41.8 weeks(22 to 56 weeks) versus 142.37 weeks(97 to 227 weeks) in Group-I & at an average follow up of 55.44 weeks (16 to 180 weeks) versus 159.3 weeks(80 to 424 weeks) in Group-II.

Group-I (lag screw osteosynthesis)

The average age in Group-I was 42 years (20 to 60 years). At average follow up of 41.8 weeks no patient had non union or AVN, all heads were viable, 6.25% had OA hip & intraarticular implant penetration, At the final follow-up 93.75% patients had union at fracture site & 6.25% patients had developed non-union (p value <0.001). No patient had AVN of the femoral head in the previous study after a average follow up of 41.8 weeks (22 to 56 weeks), however 4 patients (25%) had AVN of the femoral head at their final follow-up (p value <0.05). Only 6.25% patients had OA of the hip initially at an average follow-up of 41.8 weeks (22 to 56 weeks), whereas 25% of the patients developed OA of the hip (p value >0.05) at the time of final follow up 142.37 weeks (97 to 227 weeks).

In the previous study 93.75% patients had good to excellent Harris hip score, whereas at the time of final follow up 75% patients had good to excellent Harris hip score. The average Harris hip score in the previous study was 91, whereas in the present study the average Harris hip score was 88 (p value >0.05).

In the previous study 93.75% patients had d'Aubigne & Postel score ranging from good to very good, whereas at final follow up 75% patients had d'Aubigne & Postel score ranging from good to very good (p value> 0.05).

In previous study 93.75% patients had SF-36 score less than 10, however in the present study 75% patients had SF-36 score less than 10. Similarly average SF-36 score in the previous study was 5.19 whereas in the present study the average SF-36 score was nine (p value >0.05). [Table 1, 2, 3].

Table 1

Sr. No.	Age/Sex	Type of fracture	Previous study				Present study			
			Duration of follow up (in weeks)	Healing at fracture site	Viability of femoral head	Ficat & Arlet grade of AVN	Duration of follow up	Healing at fracture site	Viability of femoral head	Ficat & Arlet grade of AVN
1	55/F	Transcervical	25	Union	Viable	-	106	Union	Viable	-
2	35/M	Sub capital	25	Union	Viable	-	97	Union	Viable	-
3	50/M	Sub capital	52	Union	Viable	-	146	Union	Viable	-
4	55/M	Transcervical	52	Union	Viable	-	121	Union	Viable	-
5	20/M	Transcervical	52	Union	Viable	-	160	Union	Viable	-
6	40/F	Transcervical	22	Delayed Union	Viable	-	144	Non Union	Non Viable	4
7	35/M	Sub capital	56	Union	Viable	-	167	Union	Viable	-
8	26/F	Transcervical	52	Union	Viable	-	132	Union	Viable	-
9	60/F	Transcervical	30	Union	Viable	-	116	Union	Non Viable	3
10	56/M	Transcervical	52	Union	Viable	-	196	Union	Viable	-
11	35/M	Sub capital	45	Union	Viable	-	132	Union	Viable	-
12	45/M	Sub capital	25	Union	Viable	-	106	Union	Viable	-
13	45/M	Sub capital	52	Union	Viable	-	185	Union	Viable	-
14	43/M	Sub capital	25	Union	Viable	-	106	Union	Viable	-
15	50/M	Transcervical	48	Union	Viable	-	227	Union	Non Viable	2B
16	27/M	Sub capital	52	Union	Viable	-	137	Union	Non Viable	3

Table 2

S. No	Previous study			Present study		
	Osteo-arthrosis of hip	Grade of osteoar-throsis	Intraarticular implant penetration	Osteo-arthrosis of hip	Grade of OA	Intraarticular implant penetration
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	+	Fair	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	+	Good	-
10	-	-	-	-	-	-
11	-	-	-	-	-	-
12	-	-	-	-	-	-
13	-	-	-	-	-	-
14	-	-	-	-	-	-
15	-	-	-	+	Fair	-
16	+	Good	+	+	Fair	+

Table 3

S. No.	Previous study			Present study		
	Harris Hip score	d'Aubigne & Postel score	SF-36 score	Harris Hip score	d'Aubigne & Postel score	SF-36 score
1	94	Good	2.17	97	Very Good	1.33
2	92	Good	2.12	94	Good	1.71
3	93	Good	6.54	97	Very Good	2.1
4	92	Good	3.18	94	Good	2.21
5	96	Very Good	1.7	97	Very Good	1.5
6	60	Poor	48.13	52	Poor	49.19
7	95	Very Good	1.39	97	Very Good	1.33
8	95	Very Good	1.67	95	Very Good	1.61
9	92	Good	1.81	70	Medium	21.59
10	93	Good	2.13	93	Good	1.97
11	94	Good	1.93	94	Good	1.81
12	95	Good	1.39	94	Very Good	1.35
13	96	Good	1.5	97	Very Good	1.4
14	94	Very Good	1.91	94	Good	1.35
15	90	Good	2.7	70	Medium	35.67
16	90	Good	2.71	75	Medium	27.32

Group II (Valgus intertrochanteric Osteotomy)

In Group-II the average age was 52.4 years (26 to 73 years). The average duration of follow-up in the previous study was 55.44 weeks (16 to 180 weeks) & the average duration of follow up in the present study was 159.3 weeks (80 to 424weeks). In the previous study thirty-three patients (97.06%) had union at fracture site, 1 patient (2.94%) had non-union at the fracture site and no patient had delayed-

union (p value < 0.001).

In the present study 1 patient (2.94%) had non-union, no patient had delayed-union and thirty three patients (97.06%) had union at fracture site (p value < 0.001). In the previous study AVN of femoral head was observed in two of patients (5.88%) whereas in the present study 6 of the patients(17.64%) had developed AVN of the femoral head at an average final follow-up of 159.3 weeks (80 to 424weeks) (p value <0.05).

In the previous study 3 patients (8.82%) had OA of the hip. No patient had intra-articular implant penetration at an average previous follow-up of 55.44 weeks 16 to 180 weeks) whereas in the present study 14 patients (41.17%) had developed OA of the hip (p value<0.001). One patient showed & intra-articular implant penetration, between the follow-up of 26 and 92 weeks.

In the previous study 30 patients (88.23%) had Harris hip score ranging from good to excellent. In the previous study the average Harris hip score was 90 (51 to 97) whereas in the present study 25 patients (73.53%) had Harris hip score ranging from good to excellent. The average Harris hip score was 85 (48 to 97) (p value >0.05).

In the previous study thirty one patients (91.17%) had d'Aubigne & Postel score ranging from good to very good whereas in the present study 25 patients (72.22%) had d'Aubigne & Postel score ranging from good to very good. (p value >0.05).

In the previous study 27 patients (79.41%) had SF-36 score below 10. The average SF-36 score in the previous study was 7.33 whereas in the present study 24 patients (70.58%) had SF-36 score below 10. The average SF-36 score in the present study was 12.45 (p value > 0.05). [Table- 4, 5, 6]

Table 4

			Previous study				Present study			
S. No.	**Age / Sex**	**Type of fracture**	**Duration of follow up (in weeks)**	**Healing at fracture site**	**Viability of femoral head**	**Ficat & Arlet grade of AVN**	**Duration of follow up**	**Healing at fracture site**	**Viability of femoral head**	**Ficat & Arlet grade of AVN**
1	35/M	Sub capital	25	Union	Viable	-	95	Union	Viable	-
2	55/M	Transcervical	50	Union	Viable	-	106	Union	Viable	-
3	50/F	Sub capital	16	Union	Viable	-	137	Union	Non viable	3
4	55/F	Sub capital	40	Union	Viable	-	106	Union	Viable	-
5	45/M	Sub capital	52	Union	Viable	-	152	Union	Viable	-
6	50/F	Transcervical	44	Union	Viable	-	124	Union	Viable	-
7	39/M	Sub capital	42	Union	Viable	-	205	Union	Non viable	2A
8	55/M	Sub capital	25	Union	Viable	-	80	Union	Viable	-
9	65/F	Sub capital	52	Union	Viable	-	124	Union	Viable	-
10	50/F	Sub capital	25	Union	Viable	-	105	Union	Viable	-
11	47/M	Sub capital	25	Union	Viable	-	114	Union	viable	-
12	53/M	Sub capital	26	Non-union	Viable	-	92	Non-Union	Non viable	2B
13	35/M	Sub capital	25	Union	Viable	-	102	Union	Viable	-
14	74/M	Sub capital	52	Union	Viable	-	227	Union	Viable	-
15	26/M	Sub capital	25	Union	Non Viable	2A	63	Union	Non viable	4
16	60/F	Sub capital	25	Union	Viable	-	108	Union	Viable	-
17	50/M	Sub capital	55	Union	Viable	-	130	Union	Viable	-
18	43/F	Sub capital	45	Union	Viable	-	110	Union	Viable	-
19	45/F	Sub capital	52	Union	Viable	-	128	Union	Viable	-
20	65/F	Sub capital	52	Union	Viable	-	124	Union	viable	-
21	50/M	Transcervical	24	Union	Viable	-	82	Union	Viable	-
22	30/M	Transcervical	52	Union	Viable	-	151	Union	Viable	-
23	45/M	Sub capital	55	Union	Viable	-	130	Union	Viable	-
24	60/M	Sub capital	36	Union	Viable	-	110	Union	Viable	-
25	45/F	Transcervical	52	Union	Viable	-	118	Union	Viable	-
26	40/M	Sub capital	30	Union	Viable	-	76	Union	Non-viable	2A
27	45/M	Sub capital	30	Union	Viable	-	58	Union	viable	-
28	71/M	Transcervical	150	Union	Non Viable	2A	420	Union	Non viable	3
29	68/M	Sub capital	180	Union	Viable	-	380	Union	Viable	-
30	65/M	Transcervical	91	Union	Viable	-	340	Union	Viable	-
31	73/M	Transcervical	120	Union	Viable	-	424	Union	Viable	-
32	72/F	Transcervical	186	Union	Viable	-	407	Union	Viable	-
33	40/M	Sub capital	26	union	Viable	-	62	Union	Viable	-
34	60/M	Transcervical	100	Union	Viable	-	227	Union	Viable	-

Table 5

S. No.	Previous study			Present study		
	Osteo-arthrosis of hip	Grade of OA	Intraarticular implant penetration	OA of hip	Grade of OA	Intraarticular implant penetration
1	-	-	-	+	Good	-
2	-	-	-	-	-	-
3	-	-	-	+	Fair	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	+	Good	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-
11	-	-	-	+	Good	-
12	+	Good	+	+	Fair	+
13	-	-	-	-	-	-
14	-	-	-	+	Good	-
15	+	Good	-	+	Poor	-
16	-	-	-	-	-	-
17	-	-	-	-	-	-
18	-	-	-	-	-	-
19	-	-	-	+	Excellent	-
20	-	-	-	+	Good	-
21	-	-	-	-	-	-
22	-	-	-	-	-	-
23	-	-	-	-	-	-
24	-	-	-	-	-	-
25	-	-	-	-	-	-
26	-	-	-	+	Fair	-
27	-	-	-	+	Good	-
28	+	Fair	-	+	Fair	-
29	-	-	-	+	Good	-
30	-	-	-	-	-	-
31	-	-	-	-	-	-
32	-	-	-	-	-	-
33	-	-	-	+	Good	-
34	-	-	-	-	-	-

Table 6

S. No.	Previous study			Present study		
	Harris Hip score	d'Aubigne & Postel score	SF-36 score	Harris Hip score	d'Aubigne & Postel score	SF-36 score
1	94	Good	2.67	85	Good	6.6
2	92	Good	4.13	96	Very Good	1.9
3	82	Good	20.16	68	Poor	48.16
4	90	Good	4.23	90	Good	2.31
5	97	Very Good	1.36	97	Very Good	1.36
6	94	Very Good	2.1	97	Very Good	1.43
7	90	Good	13.17	70	Fair	43.17
8	90	Good	4.73	90	Good	2.16
9	90	Good	2.16	92	Good	1.73
10	95	Very Good	1.73	95	Very Good	1.61
11	97	Very Good	1.51	86	Good	11.5
12	80	Good	20.13	67	Poor	46.19
13	94	Good	6.67	95	Good	2.1
14	92	Good	4.13	93	Good	1.87
15	51	Poor	43.33	48	Poor	52.91
16	92	Good	1.93	94	Good	1.73
17	95	Very Good	1.39	95	Very Good	1.33
18	96	Very Good	2.13	96	Very Good	1.78
19	94	Very Good	1.83	97	Very Good	1.47
20	88	Good	20.13	70	Medium	38.17
21	94	Good	3.35	93	Good	2.13
22	92	Good	1.39	91	Good	1.47
23	90	Good	2.16	90	Good	1.93
24	95	Very Good	2.16	94	Very Good	1.53
25	95	Very Good	1.94	94	Very Good	1.46
26	97	Very Good	1.39	78	Medium	33.91
27	80	Medium	26	59	Fair	48.7
28	94	Good	2.6	80	Medium	13.27
29	90	Good	4.37	86	Good	6.18
30	92	Good	3.17	90	Good	5.27
31	94	Good	1.35	90	Good	3.25
32	95	Good	1.95	93	Good	2.56
33	65	Fair	36	60	Fair	30
34	94	Good	1.9	88	Good	2.41

Discussion

The radiological assessment was done by looking for union at fracture site, union at osteotomy site, AVN of femoral head, presence of OA and any other complications like intra-articular penetration of implant. Non-union was defined radiologically as failure of fixation, loss of reduction or persistence of a visible fracture line at a minimum of 6 months after surgery and clinically as the inability to bear full weight on the affected limb for one minute [4, 11]. AVN was classified radiologically as per Ficat & Arlet classification [12]. The OA was classified as per Matta's criteria [13]. The functional assessment was done by calculating the Harris hip score (modified), criteria of d'Aubigne and Postel score and SF-36 score [8-10].

Clinico-radiological results - group-I

Union at the fracture site

Patients were examined initially at an average follow-up of 41.81 weeks (22 to 56 weeks), 15 patients (93.75%) had achieved union at the fracture site and 6.25% patients had delayed-union. Further when these patients were examined finally (average follow-up of 142.4 weeks); range 97 to 227 weeks, the union rate remained same, whereas one patient (6.25%) had non-union (p value >0.05). Union rate after lag screw osteosynthesis reported in other series is as below:

Table 7

Series	Union rate (%)
Parker *et al.* [3]	81.7
Rosenbaum *et al.* [14]	70
Lee *et al.* [15]	91
Cobb and Gibson [16]	95.3
Parker [17]	87
Haidukewych [11]	92

Byung-Woo *et al.* reported 2.3% rate of non-union and 3.4% rate of non-union and AVN occurring simultaneously, in 146 hips with internal fixation of femoral neck fracture after a mean follow up of 5.2 years [18]. Karaeminogullari *et al.* reported a non-union rate of 25% for internal fixation done within 12 hours after injury and a non-union rate of 27% for internal fixation done after this interval [19].

AVN of femoral head

All the femoral heads were viable & no patient of Group-I had AVN of the femoral head. However, four patients (25%) in this group developed AVN of femoral head between 116 to 227 weeks of follow-up (p value <0.05). In our study reduction in valgus, retroverted position of the femoral head & non-union are the contributory factors in development of AVN. The rate of AVN reported in various series of lag screw osteosynthesis are as below:

Table 8

Series	Rate of AVN
Garden *et al.* [20]	21.3 %
Lee *et al.* [15]	5 %
Cobb and Gibson [16]	18.5 %
Haidukewych [11]	23 %

According to Byung-Woo *et al.* patient sex, age, interval from injury to surgery, and mechanism of injury were statistically not associated with the development of AVN. The quality of fracture reduction, adequacy of fixation, degree of displacement, and comminution of the posterior cortex were significantly associated with development of AVN. They reported an incidence of AVN of 25.3% (37 hips). The average time to diagnosis of AVN was 18.8 months [18]. Karaeminogullari *et al.* reported 12.5% rate of AVN for internal fixation done within 12 hours after injury and 14% rate of AVN for internal fixation done after this interval. They attributed this difference to the fracture displacement & time elapsed before surgery [19].

OA of hip joint

The incidence of OA of affected hip joint has not been reported in any of the series. In our study we assessed the occurrence of OA in both the groups as per Matta's criteria [13]. Initially one patient (6.25%) in Group-I had OA of hip graded as good as per Matta's criteria. One patient (6.25%) in Group-I had iatrogenic intraarticular penetration of implant. No other patient had intraarticular penetration of implant on further follow up.

Clinical presentation

In group-I twelve patients did not complain of pain or limp, any deformity or shortening & exhibited good range of movements. Pain, limp, inability to bear full weight & restriction of movements were the symptom in 4 cases who also exhibited deterioration of functional scores in comparison to their previous results.

Functional evaluation

The mean Harris Hip score was 91(60 to 96), whereas it was 88(52 to 97) at the time of final follow-up. Fifteen patients(93.75%) had the score ranging between good to excellent initially; however only twelve of these patients (75%) continued to have good to excellent score when these patients were followed up further(p value >0.05).

As per criteria of d'Aubigne and Postel score, initially these fifteen patients had the score ranging between good to very good, however only twelve patients (75%) had the score between good to very good on further follow-up (p value >0.05). Similarly these 15 patients had SF-36 score below 10 (average 5.19); range 1.39 to 48.3 initially. However on further follow-up only 12 patients (75%) had SF-36 score below 10 (average 9); range 1.33 to 49.19 (p value >0.05). In 12 patients of Group-I the functional scores either improved or did not change significantly. Only in 4 cases the scores worsened since they developed AVN of femoral head & OA of the hip joint on further follow-up.

Clinico-radiological results - group-II

Union at the fracture site

These patients were examined initially, at an average follow-up of 55.44 weeks (16 to 180 weeks) thirty-three patients (97.06%) had union at fracture site, 1 patient (2.94%) had non-union & no patient had delayed-union. However on further average follow-up of 159.3 weeks (80 to 424 weeks) 1 patient (2.94%) had non-union, the rate of union remained the same & no patient had delayed-union (p value>0.05). Union rates after valgus intertrochanteric osteotomy in other series are as below:

Table 9

Series	Union rate (%)
Rinaldi *et al.* [21]	75
Magu *et al.* [4]	94
Marti *et al.* [22]	92
Mathews *et al.* [23]	80

Magu *et al.* reported union rate of 93.3% patients at the fracture site at an average of 15 weeks and osteotomy united in all patients [24]. Norouzi *et al.* reported a fracture healing in 32 of 33 patients (96.9%) at an average time of five months (range 3–8 months) [25]. In our study the osteotomy site was united in all the patients.

AVN of the femoral head

In the initial study, AVN of femoral head was observed in two patients (5.88%) at their respective follow-up of 25 & 150 weeks. Ficat & Arlet grade of AVN 2A in both case; rest of the 32 femoral heads were viable. However on further follow-up 6 of the patients (17.64%) exhibited AVN of the femoral head. Ficat & Arlet grade of AVN was 2A in two cases, grade 2B in 1 case, grade 3 in 2 cases & grade 4 in 1 case (p value >0.05). Hence preoperative fracture displacement, fixation of femoral head in retroverted & valgus position, subluxation of the femoral head & stress concentration in the weight bearing dome of the femoral head are the likely factors leading to development of AVN & OA in our study. The rates of AVN reported in various series of Modified Pauwels' osteotomy are as below:

Table 10

Series	Rate of AVN
Rinaldi *et al.* [21]	8 %
Magu *et al.* [24]	8 %
Singh *et al.* [26]	11 %
Ballmer *et al.* [27]	17.64 %

Magu *et al.* reported 6.7% rate of AVN after valgus intertrochanteric osteotomy in patients of age 60 years or above after a mean follow up of 100 weeks [24].

OA of hip joint

Initially, 3 patients (8.82%) had OA of the hip. The grade of OA as per Matta's criteria was good in 2 cases and fair in 1 case; no patient had intra-articular implant penetration. However on further follow-up 14 of the patients (41.17%) had OA of the hip (p value <0.01). The grade of OA as per Matta's criteria was excellent in 1 case, good in 8 cases; fair in 4 cases; poor in 1 case.

Clinical presentation

In group-II 27 patients did not complain of pain or limp, not having any deformity or shortening & exhibited good range of movements. Pain, limp, inability to bear full weight & restriction of movements were the symptoms in 7 cases. None of these patients could squat or sit cross legged. The development of these symptoms & deformities was associated with worsening of functional scores in these patients.

Functional evaluation

In Group-II initially, 30 patients (88.23%) had Harris hip score between good to excellent (average 90); range 51 to 97. However on further follow-up only 25 patients (73.53%) had the score between good to excellent (average 85); range 48 to 97 (p value >0.05). As per criteria of d'Aubigne and Postel score initially 31 patients (91.17%) had score between good to very good. However on further follow-up only 25 patients (72.22%) had score between good to very good (p value>0.05). Initially 27 patients (79.41%) had SF-36 score below 10(average 7.33). Only 24 patients (70.58%) had score below 10 (average 12.45) (p value>0.05). The functional scores had worsened in the present study in 8 cases who developed AVN of the femoral head and OA of the hip joint. In rest of the patients the functional scores did not change significantly.

Rinaldi *et al.* reported 80 % very good and 8 % good results, according to d'Aubigne and Postel score; 3-5 years after primary osteosynthesis and valgus osteotomy [21]. Magu *et al.* reported 76 % excellent to good results, 18 % fair and 6 % poor results according to Harris hip score, after modified Pauwel's osteotomy [4].

Comparision of the results of group-i & group-II

In present study the rate of non-union in Group-I was 6.25% whereas the rate of non-union was 2.94% in Group-II (p value>0.05). However the rate of union appears to be better & rate of AVN appears to be lesser in group-II. The rate of AVN in Group-I was 25% whereas the rate of AVN in Group-II was 17.64% (p value >0.05).

In Group-I 25% of the patients had developed OA of the hip, whereas 41.17% of the patients in Group-II had developed OA of the hip (p value >0.05). The OA changes were secondary to AVN of the femoral head in group-I. Whereas in group-II it was secondary to valgus position, subluxation of the femoral head, intra-articular implant penetration & AVN of the femoral head.

In Group-I the average Harris hip score was 88, whereas in Group-II it was 85 (p value >0.05). In Group-I 75% patients had d'Aubigne & Postel score ranging between good to very good, whereas in Group-II 72.22% patients had score ranging between good to very good (p value >0.05). In Group-I the average SF-36 score was 9.59 and 75% patients had SF-36 score less than 10 whereas in Group-II the average score was 12.45 and 70.58% patients had SF-36 score less than 10 (p value >0.05). Hence the results of two groups are comparable in our study.

Conclusion

The incidence of complications like non-union, AVN of femoral head & OA may not be true since only 50 patients responded to our call. The commonest reason for no response of the patients could be an excellent to satisfactory result of the surgical procedure. In most of these patients period of follow-up is not enough to comment upon the ultimate result of the patients in 2 groups. However in our study the results of both the groups were comparable. Since the number of patients was small in group I and the duration of follow up was not long enough, the results may be appreciably different if they are followed further. Hence a study with more number of patients & a still longer follow-up is indicated to comment upon the statistically significant results of the two groups in terms of clinic-radiological and functional outcome. However it seems that incidence of union is better in patients managed with valgus intertrochanteric osteotomy than with lag screw osteosynthesis. Also the incidence of AVN seems to be higher in patients of group-I as compared to group-II patients. We also observed that the clinico-radilogical & functional outcomes became worse with the increase in duration of follow up in both the groups.

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