Osteosynthesis of Neck of Femur Fracture below 65 years of Age: does timing of surgery influence osteonecrosis, non-union and functional outcome?

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Citation

Thapa J, Shrestha D, Kayastha SR, Dhoju D, Shrestha R, Sharma R, et al. Osteosynthesis of Neck of Femur Fracture below 65 years of Age: does timing of surgery influence osteonecrosis, non-union and functional outcome? *Kathmandu Univ Med J.* 2021;76(4):467-73.

ABSTRACT

Background

Influence of timing of injury surgery interval in outcome of osteosynthesis of neck of femur has always been a matter of debate. Patients in our set up have been surgically treated for neck of femur fracture with wide range of injury surgery interval which could have resulted in varied functional outcome and radiological outcome.

Objective

To evaluate the difference in functional outcome, femoral head osteonecrosis and non-union in fracture neck of femur fixed within and after twenty-four hours.

Method

All patients, who had undergone osteosynthesis for the neck of femur fractures via open or closed technique from 2010 to 2018 were analyzed retrospectively. The cases were examined and evaluated in terms of injury surgery interval, fracture union, functional status using Modified Harris Hip Score, complications like femoral head osteonecrosis and non-union.

Result

Fifty patients with an average injury surgery interval of 34±28 hours were evaluated. Twenty three (46%) cases were included in early surgery group (< 24 hours) and 27 (54%) patients were included in delayed (> 24 hours) surgery group. Incidence of femoral head osteonecrosis was reported in two (4%) cases, both being in delayed fixation group (p=0.49). Non-union was reported in four (8%) patients, one in early fixation group and three in delayed fixation group (p=0.61). The average Modified Harris Hip Score in early fixation group was 87 and in delayed fixation group was 84 (p=0.1). Forty two (84%) cases had a good quality of reduction and eight (16%) had a poor reduction. Non-union and functional outcome significantly differed between the good and poor reduction group (p=0.001 and 0.004 respectively).

Conclusion

There is no significant difference in the functional and radiological outcome of cases operated before and after 24 hours for osteosynthesis of neck of femur fractures in patients 16 to 65 years age group. However, poor reduction is significantly associated with the increased rate of non-union and poor functional outcome.

KEY WORDS

Femur neck, Non-union, Osteonecrosis, Osteosynthesis

INTRODUCTION

Osteosynthesis of a neck of femur fracture (NOF) in young adults has been associated with known complications like femoral head osteonecrosis (FHO) and non-union.[1] Quality of reduction, stability of fracture reduction, timing of surgery, method of fixation, patient's age, fracture displacement pattern and quality of bone are some of the factors which determine radiological and functional outcome after neck of femur fracture.[1,2] However, timing of surgery following neck of femur fracture in young patient is still a matter of debate.[3] Early fixation of the fracture has been recommended to reduce the rate of FHO and to improve functional outcome.[1,4,5] But, various authors have compared functional outcome among patients treated in different cut off time interval ranging from 6 hours to 48 hours after injury and have found no difference between the groups.[2,6] Similarly, no significant difference has been found in the development of FHO or non-union in early and delayed fixation groups below sixty years of age.[6,7]

Delay in arrival of patients in low and middle income countries like Nepal is not uncommon. Lack of transport facilities in hilly or mountainous region, difficult terrain to access vehicle in villages and remote places, socioeconomic constraints and unavailability of air lifting for patients are some of the reasons for delaying hospital arrival after trauma. Similarly, lack of trained health personnel and facilities also make management of fracture neck of femur difficult within a given period of time.

Hence, we aimed to find out if there are any differences in functional outcome and development of non-union and FHO between early (within 24 hours) and delayed (after 24 hours) fixation groups in patients below 65 years of age group.

METHODS

This is a single centred, retrospective, descriptive, analytical study of patients between age group 16-65 years who had undergone osteosynthesis for neck of femur fracture at a tertiary care centre, from January 2010 to December 2018 with a minimum post-operative follow-up of 2 years. Patients with pathological fracture, open fracture, associated fracture of pelvis or acetabulum, patient with polytrauma and those who underwent hemi-replacement arthroplasty were excluded from the study.

A total of 140 cases were operated for neck of femur fracture in the eight years' time. Eighty-six cases (64 hemi-replacement arthroplasty, 14 above 65 years and 8 below 16 years) were excluded from the study. Among the 54 eligible cases, 4 patients had follow-up less than two years. Fifty cases were included in the final study and evaluation. Garden's classification was used for classifying the fracture into un-displaced (Garden's type I, II) and displaced (Garden's type III, IV) groups.

Operative techniques

The choice of anaesthesia was determined by the anaesthesiologist. All cases were performed by consultant orthopaedic surgeon having experience of at least 5 years. Surgery was performed in a supine position on a radiolucent fracture table. The standard technique of closed reduction was used under C-arm control and fixed with 3 cannulated cancellous screws (CCS) 6.5 mm each with washer or dynamic hip screw (DHS) with or without de-rotation screw.[8] For patients who required open reduction, Watson and Jones approach was used followed by fixation with either 3 CCS with washer or DHS with or without de-rotation screw.[9] Stainless steel implants were used from an Indian manufacturer company: Greens Surgical, having ISO standard certificate and approval from U.S. Food and Drug Administration. Achievement of final reduction was confirmed in C-arm and the wound was closed in layers.

Post-operative management, follow-up and clinical evaluation

Patients were discharged on 2nd to 4th post-operative day once the wound was dry and healthy. Post-operative protocol for ambulation consisted of toe touch weight bearing with crutches for initial 6 weeks and partial weight bearing till 12 weeks followed by full weight bearing under supervision of a physiotherapist. Patients were followed up at two weeks, six weeks, twelve weeks, six months, twelve months and then at least once a year subsequently for evaluation of fracture healing and development of FHO or non-union by check X-ray and functional outcome by Modified Harris Hip Score (MHHS).[10,11]

Garden alignment index was calculated for each patient in their post-operative X-ray to access the quality of reduction.[12] The index with an alignment angle less than 155^{o} or greater than 180^{o} in antero-posterior and lateral X-ray film was considered poor reduction whereas the angle 155^{o} to 180^{o} was considered a good reduction.[13] FHO was defined based on the appearance of subchondral sclerosis or changes in the shape of femoral head.[2] Non-union was defined as the persistence of or an increase in fracture gap, sclerosis of the margins of the fracture, alteration of the orientation of the screws in relation to the bone, breakage of the screws, change in the orientation of two fracture fragment following six months post primary surgery leading to the requirement of further surgery.[2]

Data were analysed using SPSS (version 23.0, IBM corp). Descriptive statistical methods (frequency, percentage), mean ± standard deviation, median were used to statistically analyze the data. The data were tested for normality by Shapiro-Wilk test and an appropriate non-parametric test was used for comparison of variables between the two injury surgery interval groups. Fisher's exact test was used to calculate a difference in functional outcome (good/excellent vs poor), presence of osteonecrosis or non-union between delayed and early fixation group. Mann Whitney

U test was used to calculate a difference in MHHS between the two groups. Multivariate logistic regression analysis was done to find out the variable influencing the radiological and functional outcome. A p value of < 0.05 was considered statistically significant.

RESULTS

Among the 50 patients (male: female: 1.6:1), mean age of the patients was 43.2±15 years (range 16 to 65). The most common mode of injury was fall from height (54%) followed by road traffic accident, fall on level ground and twisting injury (Table 1). The highest number of patients were included in Garden's type III (38%). There were 36%(18) patients in the un-displaced fracture group (Garden's I and II) and 64%(32) in the displaced fracture group which included Garden's III and IV (Table 1). The average duration of injury surgery interval was 34±28 hours (range 5 to 168). There were 23 patients (46%) in the early fixation group and 27 patients (54%) in the delayed fixation group (Fig. 1).

Table 1. Comparison of variables of patients treated for NOF fracture with more than or within 24 hours after injury

		Total Cases	Injury Surgery ≤ 24 hours (Early fixation group)	Interval Group > 24 hours (Delayed fixation group)	P
Number of patients		50	23	27	
Sex	Female	19	9	10	1.00 (Fischer's Exact test)
	Male	31	14	17	
Mean age		43.24±15	40.43 ± 17.4 years	45.63 ± 12.79 years	0.31 (Mann Whitney U test)
Mechanism of injury	Fall from height	27	12	15	0.29 (Pearson chi-square test)
	Fall on level ground	10	3	7	
	Road traffic accident	11	6	5	
	Twisting injury	2	2	0	
Fracture type (Garden's Classification)	I (Undisplaced)	8	2	6	0.53 (Pearson chi-square test)
	II (Undisplaced)	10	4	6	
	III (Displaced)	19	10	9	
	IV (Displaced)	13	7	6	
Method of fixation	CRIF with CCS	32	13	19	0.63 (Pearson chi-square test)
	CRIF with DHS	8	5	3	
	ORIF with CCS	5	3	2	
	ORIF with DHS	5	2	3	
Average injury surgery interval		34.32 ± 28	16.96 ± 6 hrs	49.11 ± 32 hrs	0.001 (t test)
Average follow-up period		5.32 ± 2.3	5.8 ± 2 years (2 to 9.97)	4.9 ± 2 years (2.12 to 9.75)	0.17 (t test)
Modified Harris Hip Score (MHHS) at last follow-up		84	87	84	0.1 (Mann Whitney U test)

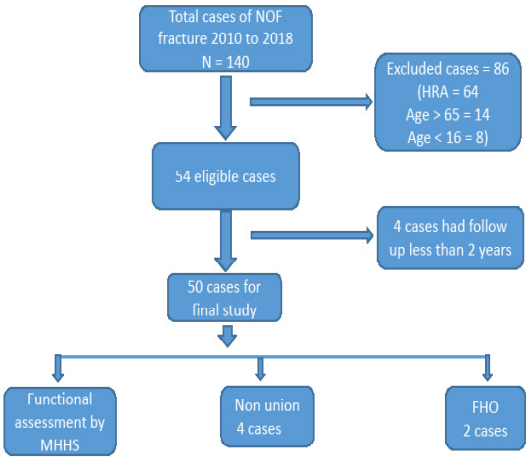

Figure 1. Algorithm of patients included for the research

The average injury surgery interval in the early group was 16.9±6 hours (range 5 to 24) and in the delayed group was 49.1±32 hours (range 25 to 168). Thirty-two patients (64%) underwent closed reduction and internal fixation with cannulated cancellous screws. Thirteen patients (26%) underwent DHS fixation. Among them, three patients (6%) underwent closed reduction and internal fixation with DHS and de-rotation screw whereas 10 patients (20%) underwent only DHS fixation (Table 1).

The average follow-up period of all the cases was 5.32±2 years (range 2 to 10). The average MHHS was 87 in early fixation group and 84 in delayed fixation group (p=0.1, Mann Whitney U test). There were two cases of FHO in the delayed surgery group (Fig. 2). There were four cases of non-union, one being in the early fixation group (Fig. 3) and three being in the delayed fixation group (Table 2).

Figure 2. a) Garden's III fracture of right neck of femur. b) AP and lateral view of X-ray hip at 2 weeks post op period. c) AP and lateral view of X-ray hip at 2 years post op showing union. d) Functional status of the patient

Table 2. Comparison of different variables with respect to injury surgery interval*

		≤ 24 hours (Early fixation group)	> 24 hours (Delayed fixation group)	P value
Functional outcome	Excellent/ Good	22(96%)	22(81.5%)	0.19 (Fischer's Exact test)
	Poor	1(4%)	5(18.5%)	
FHO	Yes	0	2(7.4%)	0.49 (Fischer's Exact test)
	No	23(100%)	25(92.6%)	
Non-union	Yes	1(4%)	3(11%)	0.61 (Fischer's Exact test)
	No	22(96%)	24(89%)	

*The values are given as the number of patients with the percentage in parentheses

All cases of non-union were present in displaced type of fracture (Garden's III and IV). One case of FHO was present in each displaced and un-displaced fracture type. There was no statistically significant difference in functional outcome (p=0.39), rate of FHO (p=1) and non-union (p = 0.28) in between the displaced and un-displaced fracture groups (Table 3).

There were 42 cases of good quality of reduction and 8 cases of poor reduction (Fig. 3). Non-union and functional outcome significantly differed between the good and poor reduction groups (p=0.001 and 0.004 respectively) whereas both the cases of FHO occurred in good reduction group which was not statistically significant (p=1.0) (Table 4).

Table 3. Comparison of different variables with respect to fracture displacement*

		Undisplaced (Grade I and II)	Displaced (Grade III and IV)	P value
Functional outcome	Excellent/ Good	17(94.4%)	27(84.4%)	0.39 (Fischer's Exact test)
	Poor	1(5.6%)	5(15.6%)	
FHO	Yes		1(3%)	1 (Fischer's Exact test)
	No	17(94.4%)	31(97%)	
Non-unionv	Yes	0	4(12.5%)	0.28 (Fischer's Exact test)
	No	18(100%)	28(87.5%)	

*The values are given as the number of patients with the percentage in parentheses

Figure 3. a) X-ray hip AP view showing Garden's II neck of femur fracture. b) X-ray hip AP and lateral view at 2 year post op showing union. c) X-ray hip AP and lateral view showing FHO at 4.5 years follow up. d) X-ray hip AP showing Total Hip Replacement for the FHO.

Table 4. Comparison of different variables with respect to quality of post-operative reduction*

		Good reduction	Poor reduction	P value
Functional outcome	Excellent/ Good	40(95%)	4(50%)	**0.004** (Fischer's Exact test)
	Poor	2(5%)	4(50%)	
FHO	Yes	2(5%)	0	1.0 (Fischer's Exact test)
	No	40(95%)	8(100%)	
Non-union	Yes	0	4(50%)	**0.001** (Fischer's Exact test)
	No	42(100%)	4(50%)	

*The values are given as the number of patients with the percentage in parentheses

Multivariate logistic regression was performed using functional outcome, non-union and FHO as the dependent variable. Only reduction quality was found to be significantly associated with functional outcome (p = 0.01, Odds Ratio = 0.04, 95% CI = 0.003-0.536). None of the other variables was found to be significant predictors for development of non-union and FHO (Table 5).

Total hip replacement was performed for the two cases of FHO at 3.5 years and 4.5 years (Fig. 2) of primary surgery and the four cases of non-union at 9 months (Fig. 3) to 12 months of primary surgery.

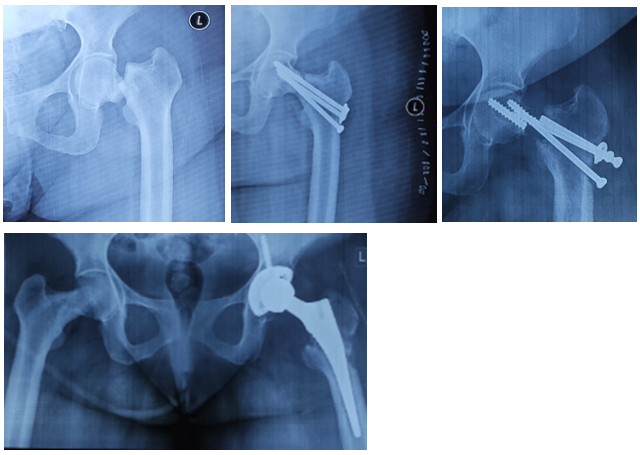

Figure 4. a) X-ray hip AP view showing Garden's IV neck of femur fracture. b) Immediate post op X-ray AP view. c) Non-union with implant failure at 9 months follow up. d) Total Hip Replacement for the non-union.

Table 5. Regression Coefficients for predictors of functional outcome (MHHS), development of FHO and Non-union

Variable	Functional outcome (Good/Excellent or Poor)			Non-union (Yes/No)			FHO (Yes/No)		
	p value	Odds Ratio	95% CI'	p value	Odds Ratio	95% CI'	p value	Odds Ratio	95% CI'
Age	.58	1.02	.94-1.11	.31	.82	.55-1.2	.76	.98	.87-1.1
Injury surgery interval	.52	.99	.96-1.02	.28	1.08	.93-1.27	.23	.96	.9-1.02
Fracture displacement	.88	1.23	.06-24.06	1.0	1.69	.00-NA€	.66	2.44	.04-135.3
Quality of reduction	.01*	.04	.003-.536	.99	2.27	.00-NA€	.99	.00	.00-NA€

*Variable with significant p value, 'CI, confidence interval, €NA, not available-

DISCUSSION

The present study showed that there is no significant difference in MHHS and development of FHO or non-union for the treatment of the neck of femur fracture in between early fixation group (≤ 24 hours) and delayed fixation group (> 24 hours) in 16 to 65 years age group patients.

Injury surgery interval has always been a matter of debate concerning the outcome of the neck of femur fracture. Some author suggested that osteosynthesis done within the first six hours improves both functions and FHO rates, whereas others reported that there is no relationship between risk of developing nonunion or FHO and injury surgery interval.[2,14-16]

Haidukewych et al. and Gumustal et al. have evaluated the neck of femur fracture on the basis of fixation done within or after 24 hours.[15,17] Different authors have taken a different time frame for fixation, ranging from 6 hours to 48 hours.[2,14,16,18] Most of the patients (n=41, 82%) in our study have reached the hospital not earlier than 18 hours. A large number of patients taking services from our hospital are residing in hilly regions which is a difficult terrain with lack of transportation facilities and unavailability of air lifting services leading to delay in reaching the hospital. Hence we considered 24 hours as a cut off value for classifying the fixation groups into two groups in the present study.

FHO is a serious and unpredictable complication that occurs due to disruption of blood supply around the neck of femur.[6] Its incidence in literature has large variation ranging from 16% to 86%.[2,6,19,20] However in our study the rate of FHO was found to be quite low (4%). Among the two cases, one developed FHO at 4.5 years period and the other developed FHO at 3.5 years period. Presentation of FHO can be anywhere between 6 months to many years after the primary injury, however, most cases will present within 2 years.[3,21] Various studies have considered 2 years as a minimum time frame to detect FHO after osteosynthesis of femoral neck fracture.[6,17,22] The current study has 43 (86%) cases with follow up period of more than 2 years [(3 years: 9(18%), 4 years: 9(18%), more than 5 years: 25(50%)]. Hence, two years was considered as a minimum period of follow up in our study. Asnis et al. demonstrated the rate of FHO increased from 11% in two years period to 22% in eight years follow up.[23] So there might be some chances of development of FHO in the present study if followed up for a longer period of time. Razik et al. reported no evidence to support early surgical fixation that decreased the FHO risk.[6]

Rather they emphasised the method of internal fixation to be more predictive of the FHO. Papakostidis et al. failed to prove any essential association between injury surgery interval and the incidence of FHO.[24] However they found, delay of injury surgery interval by more than 24 hours could increase substantially the odds of non-union.

Rate of non-union has been reported to be 10-30% in different literatures.[2,17,25,26] In the present study the non-union rate was 8% which is lower than the above literatures. Of the four patients who developed non-union, all had displaced fracture and there was early loss of reduction during the post-operative period. All of them presented with breakage of screw and displacement of fracture after six months of surgery. Some study showed both biological and mechanical parameters contribute to the development of non-union.[24] Lack of periosteal cambium layer of femoral neck and presence of the synovial fluid at the fracture site are the biological parameters.[27] The amount of vertical inclination of the fracture line, quality of reduction, stability of fixation and integrity of the posterior cortex are the mechanical factors.[24]

In our study, we found that FHO occurred in both displaced and un-displaced fracture whereas non-union of fracture occurred only in displaced type fractures. Non-union has occurred in all 4 cases where post-operative reduction was poor (p=0.001) whereas FHO has occurred even in those 2 cases with good post-operative reduction (p=1.0). Greater the amount of displacement of neck of femur at the time of injury, larger will be the vascular disruption increasing the chances of development of FHO despite of quality of reduction and methods of fixation. Whereas non-anatomic fixation or poor post-operative reduction will lead to poor environment for fracture healing resulting in non-union of the fracture. Our study has similar findings to the studies of many authors who advocate quality of reduction and stability of fixation as a high priority for its better functional and radiological outcome.[16,21,28,29]

After conducting multivariate logistic regression analysis we found quality of reduction was the only significant predictors for functional outcome. The injury surgery interval, age and fracture displacement were not significant predictors for functional outcome, non-union and FHO. These findings were in contrast to the assumption of a direct relationship between development of FHO and fracture type, age, time of fixation.[30] Our findings of association between injury surgery interval and development of FHO is similar to the study by Loizou et al. where they didn't find association between the incidence of FHO and injury surgery interval.[31] However, with regard to non-union our findings are in contrast to the other studies where they have mentioned good quality of reduction and stable fixation would influence in development of fracture union with good functional outcome.[6,16,21,24,28,29]

This study is a single centred retrospective study with a small sample size which makes generalisation of findings of this study difficult. Despite several limitations of the current study, patients presenting within or after 24 hours of injury fall into two distinct categories reducing the chances of selection bias and hence represent near to actual scenario of orthopaedics practise in low to middle-income countries. Despite being a referral centre and with a fairly long duration of study, we could analyse 50 patients in the study. For a prospective study to have sufficient power (α=0.05 and power of 80%) with the same complication rate, we would need 77 patient in each arm of the study which was not feasible in our single centre study. In conclusion, there was no significant difference in the functional outcome (MHHS) and development of FHO or non-union for fixation of fracture neck of femur done before and after 24 hours in patients 16 to 65 year's age group. However, poor reduction is significantly associated with an increased rate of non-union and poor functional outcome. We recommend performing a large multi-centric prospective study with long term follow-up to find out factors influencing the outcome of fracture neck of femur.

CONCLUSION

No significant difference in the functional outcome (MHHS) and development of FHO or non-union was found for fixation of fracture neck of femur done before and after 24 hours in patients 16 to 65 year's age group. However, poor reduction is significantly associated with increased rate of non-union and poor functional outcome. We recommend performing a large multi-centric prospective study with long term follow-up to find out factors influencing the outcome of fracture neck of femur.

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