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Dynamic Hip and Cannulated Screws in Fixation of Adults Femoral Neck Fracture: A Comparative Study

Adnan Essa Al-kelabi[1]* and Mustafa Shakir Mahmoud[2]

[1] FICMS, Professor of Orthopedic Surgery, Consultant Orthopedic Surgeon, University of Kufa, Medical College, Najaf, Iraq

[2] FICMS, Orthopedic Surgeon, AlSader Medical City, Najaf, Iraq

**Corresponding e-mail: najafoffice82@gmail.com*

ABSTRACT

Objective: *To evaluate the best results that can be obtained by applying two different ways of fixation in the treatment of femoral neck fracture in adults.* ***Methods:*** *A prospective comparative study carried out on 46 patients aged 18-60 years who had trans cervical femoral neck fracture. Patients were classified according to Garden classification and assigned into two groups to be treated either with multiple cannulated screws or dynamic hip screws. All patients were treated between 2-7 days after injury and followed up for 8-18 months.* ***Results:*** *There was significantly longer incision in DHS group, p=0.003 and the intraoperative blood loss was significantly more in DHS group as well, p=0.008. There was an increase in the rate of complications with increasing age, p=0.022. Avascular necrosis occurred in 4 patients (8.6%), 2 patients in each group, nonunion developed in 17.4% (4 patients) in MCS group and 13% (3 patients) in DHS group. There was no association between two groups in operative time, HHS, union rate and the post-operative complications.* ***Conclusion:*** *The multiple cannulated screws being minimally invasive can be used adequately to treat trans cervical femoral neck fracture in adults.*

Keywords: Femoral neck fractures, Compression screws, Capsulotomy, Avascular necrosis

INTRODUCTION

Femoral neck fracture in adult results from high energy trauma with higher incidence of complications. Normal anatomy of the hip and mechanics are mandatory to be preserved by anatomic reduction and stability of internal fixation [1,2]. Among elderly, the injuries differ than younger population. In older injured patients, there is a high comminution, a higher frequency of associated skeletal and visceral injuries and a greater disruption of blood supply to the head of femur [3]. Fractures of hip constitute almost 20% of the surgical fractures. Fracture of the femoral neck is the more frequent among all fractures of the hip region. It accounts for about 50% of these fractures [4,5]. Intra capsular femoral neck fractures in young adults account for only about 3% of the total hip fracture population [3,6]. The Increase in high-energy traffic accidents and popularization of extreme sports that exert limits make the young population also prone to such fractures [7]. Their incidence in non-elderly population has been reported as low as 5 in 10,000 population per annum [8,9]. Hip fractures are associated with 30% mortality in first year and a profound temporary, sometimes permanent impairment of independence and quality of life [8-11]. The overall mortality in the non-elderly population has been previously reported as high as 5.7%, within the first-year post injury [12].

The clinical evaluation of these patients requires a thorough trauma workup because they frequently have other associated injuries. Despite this, diagnosis, and treatment of femoral neck fractures in young adults should only be superseded by other life and limb-threatening injuries [13-23]. Patients often have multiple injuries and in 20 per cent, there is an associated fracture of the femoral shaft [13]. In clinical practice, standard radiographs can miss up to 2-10% of femoral neck fractures, the CT scan could help in diagnosis [14]. MRI could reduce the chance of a missed injury [15]. Although there is consensus in the literature that anatomical reduction and stable internal fixation should be the goal of treatment of these fractures, the exact role of timing of operative intervention is less clearly ascertained [16,17].

The return to the pre-injury function represented the main goal of surgical management additionally guarantees the intact blood supply, anatomic reduction, effectively prevent avascular necrosis (AVN) and provide a stable fixation while preserve the bone stock and achieve the union [2]. Fixation should always be considered over arthroplasty, although consent should include the requirement for limited weight bearing and regular follow-up postoperatively, as well as the risk of subsequent conversion to THR [18]. Capsulotomy in femoral neck fractures remains a controversial issue.

During weight bearing, the compression screws (CS) and fixed dynamic implant, or a combination of both, promoted union during weight bearing body permitting the fracture fragments to slide alongside the implant whereas being axially loaded [24-30] multiple compressive screws are applied as lag screws and can be inserted percutaneously, or through a minimal surgical approach [19]. A lot of studies investigated the number, type, thread length and the configuration of the screws. Three screws were more stable than two screws [20]. The dynamic compressive screw had been supported as a firmer construct than compressive screws for high shear angle neck fractures (pauwelsd typed III) [21]. It provides increased resistance to Varus collapse compared with parallel screws while also allowing compression along the axis of the femoral neck for most femoral neck fractures. Some complication might occur in some patients. These include avascular necrosis, non-union and osteoarthritis [13].

METHODS

This was a prospective comparative study conducted at Al-Sadr Teaching Hospital in Al-Kufa city. Forty-six patients (5 females, 41 males), 18-60 years old, were operated in 2015 with follow up period of 8-18 months. Patients presented to the emergency department with acute trans cervical femoral neck fracture diagnosed by plane radiograph and assigned randomly into two groups: Group 1 included 23 patients treated with MCS, Group 2 included 23 patients treated with DHS. Patients classified according to Garden classification: 13 patients were Type I, 7 patients Type II, 10 patients Type III and 16 patients Type 4. Patients with extra capsular fracture, pathological fracture and those who had life threatening injuries like abdominal and head injury were excluded from the study. The mechanism of injury was FFH, car accident, crush injury and MCA.

Operative Technique

Prophylactic antibiotic (1 gm ceftriaxone) was given 1 hour before skin incision. Spinal anesthesia was used in all patients, closed reduction was first tried. In patients treated by cannulated screws, the proximal femur is approached through limited longitudinal lateral incision from just distal to the greater tubercle to 6-8 cm. Distally, retraction of the skin and subcutaneous tissue exposing the tensor fascia lata which in turn incised longitudinally along skin incision, then splitting of the vastus lateralis muscle along its fibers to expose the bone. Then insertion of pin along the anterior aspect of the neck to determine the amount of ante version, and using pin angled guide on the lateral aspect of the femur for insertion of the 2 mm pins in to the femoral neck in a triangular configuration, they were kept about 5 mm from the subchondral bone, and the position was confirmed by image intensifier on AP and lateral views. Self-tapping 6.5 mm partially threaded screws inserted and tightened sequentially, and the position confirmed on C-arm.

At the end of fixation, the guide pins were removed, securing good hemostasis, irrigation of the wound by physiological saline, insertion of closed suction drain, closure of the fascia lata continuously using absorbable suture material, suturing of the subcutaneous layer by interrupted absorbable material, closure of skin by interrupted non-absorbable suture material and dressing.

In patients treated by dynamic hip screw, using the same approach but the incision need to be extended slightly distally for insertion of side plate, a guide pin to determine the amount of anteversion was also used as in MCS, a second 3.2 mm guide pin was inserted centrally in to the femoral neck 5 mm from subchondral bone using appropriate angle guide, and confirmed on AP and lateral views, another pin parallel and cephalad to the central pin was used to prevent femoral head rotation during reaming. A triple reamer set was assembled to 5 mm shorter than the length of central pin, thus keeping tip apex distance less than 25, reaming was done over the central pin, 12.7 mm tapper was used for tapping, insertion of 12.7 mm head screw was done, then 135 degree side plate with 2-4 holes was inserted

as its barrel has a cam that is slides over the slots presented in the head screw, then the plate fixed to the shaft with ordinary 4.5 mm cortical screw, a compression screw was inserted through the barrel of the side plate to attach the head screw to make compression across the fracture site. Finally, the superior pin was removed, and the wound was closed in layers over suction drain and same steps were followed in MCS procedure. With failure to obtain anatomic reduction after 3 attempts at closed reduction which occurred in 9 patients (20%), we proceeded with open reduction.

Postoperative care in the ward encouraged breathing exercises and foot movement while in bed. Injectable antibiotics continued after the operation for 5-7 days, with adequate analgesia. On the second post-operative day, the patient is able to sit in bed, post-operative checking radiograph is obtained. The follow up period was ranged from 8-18 months in all patients. The follow up visits carried out at 4th week bimonthly. At each visit, the patient was evaluated for general condition, limping, any deformity by using Harris hip score, X-ray in the form of AP. Statistical analysis was performed using the statistical package for social sciences (SPSS) version 24. Descriptive statistics were presented as mean, median, standard deviation, frequencies, and proportions, or mean and standard deviation. Appropriate statistical tests were used accordingly.

RESULTS

No statistically significant differences had been found in operative time between both groups, (Table 1), (P>0.05). Intraoperative blood loss was significantly less in MCS than DHS group. The median blood loss was 150 cc (100 cc to 220 cc) and 180 cc (100 cc to 300 cc), respectively, (P<0.05), (Table 2).

Table 1 Comparison of operative time among the studied groups

Operative time (minutes)*	MCS Group		DHS Group		P-value
	No.	%	No.	%	
< 70	6	26.1	1	4.4	0.23
70-79	7	30.4	8	34.8	
80-89	6	26.1	9	39.1	
≥ 90	4	17.4	5	21.7	
*Median operative time in MCS group = 75 (range 60-130); Median operative in DHS group = 80 (range: 65-150)					

Table 2 Amount of Intraoperative blood loss among the studied groups

Intraoperative blood loss (cc)*	MCS Group		DHS Group		p-value
	No.	%	No	%	
100-150	13	56.5	8	34.8	0.008
160-200	9	39.1	11	47.8	
200-300	1	4.4	4	17.4	
Total	23	100	23	100	
*Median blood loss = 150, (range: 100-220) cc, in MCS group; Median blood loss = 180 (range: 100 – 300) cc, in DHS group					

No statistically significant difference had been found neither in time of radiological union (Table 3), nor the Harris Hip Scores (Table 4), when compared with the studied groups for these variables, (P>0.05). The frequency of all complications was insignificantly different between both groups, in all comparison, P>0.05, (Table 5).

Table 3 Time of radiological union in patients of the studied

Time (week)	MCS		DHS		p-value
	No.	%	No.	%	
18	3	15.8	3	15	0.95
22	5	26.3	4	20	
24	6	31.6	5	25	
26	4	21.00	6	30	
28	0	0.00	1	5	
30	1	5.30	1	5	
Total	19	100	20	100	

Table 4 Harris Hip Scores of patients in the studied groups

Harris Hip Score	MCS		DHS		p-value
	No.	%	No.	%	
Excellent (90-100)	6	26.1	6	26.1	0.98
Good (80-89)	9	39.1	10	43.5	
Fair (70-79)	2	8.7	2	8.7	
Poor (<70)	6	26.1	5	21.7	
Total	23	100	23	100	

Table 5 Postoperative complication of the studied groups

Complication*	MCS		DHS		P-value
	No.	%	No.	%	
Nonunion	4	17.4	3	13	1.00
Infection	2	8.7	3	13	1.00
AVN	2	8.7	2	8.7	0.6
DVT	1	4.3	1	4.3	0.47
None	14	60.9	14	61	0.76
Total	23	100	23	100	-
Two patients had combined complication, fixation failure and nonunion/AVN					

Among the 46 patients in both groups, the nonunion was the more frequent complication, (in 7 patients) followed by infection (in 5 patients), AVN in 4 patients and DVT in two patients. However, totally 18 patients had postoperative complications and 28 had not. Postoperative complications were insignificantly associated with method of reduction, in all comparison (P>0.05), (Table 6). In Table 7, patients who developed complication were significantly older than those who did not, the mean age was (43.1 ± 12.6) and (34.4 ± 12.1) years, respectively.

Table 6 Relationship between complication and method of reduction

Complication*	Closed (n=37)		Open (n=9)		OR* (95% CI)	P-value
	No.	%	No.	%		
Nonunion	5	13.5	2	22.2	1.6 (0.39 – 6.6)	0.61
Infection	3	8.1	2	22.2	2.24 (0.69 – 8.5)	0.28
AVN	4	10.8	0	0.00	-	1.00
DVT	2	5.4	0	0.00	-	1.00
Total complication	14	37.8	4	44.4	1.24 (0.38 – 4.1)	0.72
None#	23	62.2	5	55.6	1	0.72
* OR: Odds ratio, CI: confidence interval; # None used as reference category						

Table 7 Relationship between complication and age of the patients

Complication	No. of patients	Mean age	SD
Yes	18	43.1	12.6
No	28	34.4	12.1
t test = 2.37; P-value = 0.022			

DISCUSSION

The best surgical fixation in femoral neck fractures is essentially to be able to resist the forces of weight-bearing and limiting movement through the site of fracture during healing process, to promote quick and secured recovery of the patient and to render his/her routine activities. Secured fixation also decrease the incidence of treatment related complications [5]. The surgical incision was longer in DHS group with a median of 10 (range: 8-17) compared to MCS group (median of 7 (range: 6-14) which is different significantly p<0.05. This was also found in a study performed by Gupta, et al. [18] with average incision of 12.6 cm (8-20) in DHS group and 3.0 cm (2.5-5.5) in MCS group. The discrepancy with incision may be due to use of different length of the side plate in DHS and shifting to open reduction in some patients.

Regarding the operative time, in DHS group it was 80 minutes (65-150 minutes) while in MCS it was 75 minutes (60-130 minutes), however, it was statistically insignificant, p>0.05. Multiple studies revealed longer operative time taken in DHS surgery than in MCS as in study of Kaplan, et al. [7] who compared percutaneous MCS to DHS which revealed the time taken by the MCS was 46 minutes (15-60 minutes) while in DHS, it was 95 minutes (50-140 minutes). This difference in operative time may be due using minimally invasive technique in screw insertion in the author study while shifting in some patients to an open technique in our study. In our study, the intra-operative blood loss was compared between the two groups. It was significantly less in MCS 150cc (100 cc to 220 cc) than DHS 180 cc (100 cc to 300 cc) and it was significant statistically p<0.05. Wenbo, et al. [21] in 2014 estimated the blood loss in their study on fixation of femoral neck fracture in elderly by DHS and they found that it was 60 cc (55 cc to 80 cc). Similarly, the blood loss in MCS was also smaller 67.4 (30 cc to 150 cc) than DHS 200 cc (100 cc to 400 cc) in the study of Gupta, et al. [6]. This might be related to more soft tissue stripping in DHS group [23]. By using the minimally invasive DHS, there is less operative time, less intraoperative blood loss and smaller incision than the conventional technique [24]. By using Harris hip score (HHS) for assessment of hip joint function, our study found that in MCS resulted in excellent results in 6 patients (26.1%), good in 9 patients (39.1%), fair in 2 patients (8.7%) and poor in 6 patients (26.1%). In DHS group, excellent results were observed in 6 patients (26.1%), good in 10 patients (43.5%), fair in 2 patients (8.7%) and poor in 5 patients (21.7%) with no significance between the two studied groups and similar non-significant results are supported by Kuokkanen, et al. study [25], in his study that was performed on 33 patients treated by either DHS or MCS. While in Hou, et al. study [26], the HHS for DHS (91.0) was higher than MCS (85) p<0.01 (55) when they studied 67 patients treated by either DHS or MCS. Healing of the fracture was indicated by X-ray by the continuity of the trabecular pattern of the femoral neck, good walking ability and disappearance of hip pain [27]. In our patients there was no significant difference (p>0.05) in the healing time between the two groups with healing time range from 18 to 30 weeks in both and healing rate was 78.2% in MCS and 82.6% in DHS group. This was different from a study conducted by Wenbo, et al. [20] on 60 elderly patients treated by DHS, which revealed fracture healing of the femoral neck ranged from 3-6 months (average 3.5) with healing rate was 97.6%. In Swiontkowski, et al. study, which was performed on 27 patients aged 12- 49 years with femoral neck fracture treated by multiple cancellous screws, the surgery accomplished in the first 8 hours after injury, revealed healing of all the fractures within 16 weeks. This inconsistency in healing time may be due to difference in the number of patients having different fracture displacement according to Garden classification which might affect the healing rate [28]. High rate of complications was noticed after all types of femoral neck fracture in adults, more in sub capital fracture and it was independent of the health status, method of treatment, degree of displacement, and mechanism or severity of injury, these were the results of the study of Dedrick, et al. [29]. The incidence of all post-operative complications in our study were insignificantly different between both groups in all comparison, P>0.05. Among the 46 patients in both groups the nonunion was the more frequent complication, (in 7 patients) followed by infection (in 5 patients), AVN in 4 patients and DVT in two patients. So totally 18 patients had postoperative complications and 28 had not. In respect to AVN the present study shows 2 cases of AVN (8.7%) in each group. So, there was no difference in both groups, these finding was not unexpected when similar association was supported by Siavashi, et al. [30] in his randomized clinical trial on 58 patients with one year follow up. Contrary to our results, a study carried out by Min, et al. [31] on 163 patients had intracapsular femoral neck fracture with follow up period ranged from 3 months to 7 years treated by either DHS or MCS showed an incidence of AVN of 25.5% with average time for diagnosis by X-ray was 18.8 months (range 3-47 months). The discrepancy between these results and our results may be due to short period of follow up in our study as 80% of patients with AVN need at least 2 years to be diagnosed [32] or due to small sample size. Of the 4 patients with AVN, non-cemented total hip replacement was done in two patients after failure of conservative treatment, one 45 years old and another patient was 53 years, both did well after surgery. The other two patients are prepared and put on the waiting list for surgery to be done later. Non-union usually can of course be diagnosed within a period of a year of fracture fixation with the same being achieved within 3 months at times [33]. The incidence of non-union in our study was 17.4% (4 patients) in MCS group compared to 13% (3 patients) in DHS group and did not reach the statistical significance, p>0.05. The rate of nonunion was estimated by a study of Slobogean, et al. [34] and it was 9.3% with similar results was found by Damany, et al. study, who found nonunion rate of 8.9% [3] in meta-analysis performed included 18 studies. The difference in reading is due to small number of the patients were present in the study. Of the patients who developed non-union, 2 patients converted to non-cemented total hip, 2 other patients refused the surgery and preferred to be on conservative treatment, other one patient waiting for surgery to be done, the other patients were lost from follow up in the late period of our study.

When we compared the method of reduction (open versus closed) and the incidence of complications, our results failed to give us any significant associations, $p>0.05$. Similar results were observed by Zishan, et al. [35] when no significant differences were found between open and closed reduction. While in a study of wang, et al., they found that AVN occurs more frequently after closed reduction [36]. In comparison with mean age, it appeared to us that the incidence of complications was more frequent with increasing age. Of particular importance is the AVN and nonunion. In AVN the mean age was (51.3 ± 8.1) vs. (34.4 ± 12.0) with no AVN and it was statically significant, $p=0.005$. In nonunion, the mean age was (47.0 ± 9.7) vs. (34.4 ± 12.0) with no nonunion which is also significant, $p=0.008$. In a study done by Schweitzer, et al. [37], they were evaluated the factors associated with AVN and nonunion in patients younger than 65 years with displaced femoral neck fracture treated by reduction and internal fixation. They concluded that patients between 53.5 and 65 years old at higher risk of AVN and primary arthroplasty should be considered in this group. On the other hand, a study done by Parker, et al. [38], they investigated the association between age and healing problems of femoral neck fracture and concluded that there is an increase in intracapsular femoral neck fracture developing nonunion with increased age. This may be related to severity of cases at the time of fracture [39], or the alteration of body physiology that occur with increasing age especially that related to fracture healing with decrease bone formation activity in the aged subjects due to decreased numbers of osteoprogenitor cells differentiate to osteoblasts [40], or declining in chondrogenic potential of the periosteum that is required for fracture healing with aging [41].

The other complications in this study like DVT and wound infection was not different in both groups $p>0.05$ results that was also supported by Hou, et al. study [26]. The 5 cases who developed infection were 2 (8.7%) in MCS group and 3 (13%) in DHS group and it was superficial cellulitis treated with continued injectable antibiotic and there was no need for surgical intervention. Two patients of DVT, one in each group, treated after consultation of vascular surgeon with enoxaparin in therapeutic dose and then continued warfarin.

CONCLUSION

Both methods consumed almost the same operative time, having equal healing rate, hip function, and the postoperative complications. Multiple cannulated screw can safely be used in treatment of femoral neck fracture which can be inserted with minimal invasive techniques. Hence, treating trans cervical femoral neck fracture by using cannulated screw could provide good stability by compressing the fracture site by lag effect of the screw and maintaining reduction, with less blood loss, smaller skin incision and with small scarring which contribute to better cosmetic appearance and can achieve good fracture healing. However, larger multicenter studies are needed for further evaluation of such procedure.

DECLARATIONS

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Conflict of Interest

The authors report no conflict of interest.

Ethics and Consent

Data of participants were collected according to the Declaration of Helsinki, and signed informed consent was obtained from each participant who was informed about the nature of the study and the surgical procedures that were performed.

The study was approved by the ethics committee of the medical college, university of Kufa and the ethical committee at AlSader Medical city,

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