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A comparative study of treatment outcomes of femur neck fracture with dynamic hip screws versus multiple cancellous cannulated screws

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***Abstract*---**Background: Dynamic hip screws (DHS) and multiple cannulated cancellous screws (MCCS) are commonly used in anatomic reduction of femur neck fractures. However, there is limited information on the complications of various fixation methods. Objective: To assess the outcome of two different modalities of femur neck fracture fixation. Methodology: This prospective, randomized, comparative interventional study included 32 subjects with recent trauma. Patients were randomized to DHS and MCCS treatment groups (16 patients each). Post-surgical radiographs were obtained and clinical evaluation for deformities was performed using the Harris hip score (HHS). The duration of surgery, average blood loss, and complications were noted and assessed. Chi-square test was used to check the association between attributes. Two-sample *t*-test was employed to compare the mean between two groups. $P \leq 0.05$ indicated statistical significance. Results: A significant difference ($p<0.001$) between the 2 groups was noted with regard to patients' age. The median operative time for DHS and MCCS groups was 75 mins (range 60-90 mins) and 60 mins (range 50-70 mins), respectively. Average blood loss was more in DHS (200 mL) than in MCCS (120 mL) group. Majority of the patients (75%) in the DHS group showed excellent HHS results. The average duration for radiological union was 12 weeks and 13 weeks in DHS and MCCS groups, respectively. Femoral neck shortening was absent in DHS group. No significant difference in complications was observed between the groups. Conclusion: Fixation

with DHS showed better clinical outcomes compared to MCCS. Both the groups had similar complications with avascular necrosis and non-union.

***Keywords*---**Bone screws, Catheterization, Femur neck fracture, Radiography.

Introduction

Femoral neck fractures are commonly accompanied by 50% of hip fractures, contributing to both morbidity and mortality.[1] They occur mainly due to osteoporosis and trivial falls in elderly people whereas, in young adults, they usually are a result of high-energy trauma such as traffic accidents and falls from a height.[2-4] Various studies have reported that femoral neck fractures are associated with complications like avascular necrosis (AVN), implant failure/revision, non-union, and even death.[5]

Despite the development of various treatment modalities including implant designs, imaging methods, and surgical techniques, the femoral neck fracture still poses a formidable challenge to the modern orthopedic surgeons. The current treatment options include arthroplasty for older individuals and internal fixation and anatomical reduction for younger patients.[6],[7] The fixation procedures such as valgus osteotomy, fixation with double-angle barrel/blade plate, displacement osteotomies, fibular graft, muscle pedicle grafts, dynamic hip screw (DHS), and multiple cancellous cannulated screw (MCCS) with internal fixation are used.[8]

DHS and MCCS are widely used in young patients. Few studies have demonstrated that MCCS has better biochemical properties with regard to anti-rotation and anti-stress ability which could be employed in non-displaced intracapsular fractures.[9],[10] Some other studies have reported that DHS is efficient in fracture fixation by maintaining the neck-shaft angle and anatomical reduction. However, fractures have long been observed to be inherently unstable, making it difficult to choose the ideal implant for fixation.[11-13] Although DHS and MCCS are both capable of accomplishing compression at the fracture site, they differ in their strengths for maintaining a reduction. Clinical evidence of superiority of implants in terms of complications like avascular necrosis (AVN) and non-union, which require revision surgery, is limited.[14] Therefore, the current study aimed to assess the outcome of two different modalities of fixation in the treatment of femur neck fractures.

Materials and Methods

Study design

This prospective, randomized, comparative interventional study was carried out on 32 subjects with recent trauma, in a tertiary care centre at Karad, Maharashtra from June 2017 to June 2019. The study was conducted after obtaining approval from the institutional ethics committee and a written informed

consent from the participants. The sample size was calculated based on the convenient sampling method.

Selection criteria

Subjects of both genders aged 18 to 50 years with recent trauma and who were fit for surgery with no other associated fractures were included in the study. Patients with pathological fractures; other associated comorbidities such as uncontrolled diabetes mellitus; infectious conditions of the hip; previous history of hip surgery, neglected femur neck fracture; patients unfit for surgery; and those unwilling to undergo surgery were excluded.

Sample randomization

Information such as mode of injury and time since trauma was obtained. A thorough clinical examination was conducted. Radiographs were obtained in anterior-posterior (AP) and lateral views, and the diagnosis was confirmed by radiological evaluation. Patients were admitted and ankle traction was applied. All routine surgical investigations were done, and patients were posted for surgery on an emergency basis. All of them were given intravenous antibiotics (Ceftriaxone) 30 min prior to surgery. They were randomized into two interventional groups consisting of DHS and MCCS techniques, with 16 patients in each group.

1) Dynamic hip screw technique

Patients were given spinal anesthesia and shifted onto the fracture table. The fracture site was reduced using Leadbetter technique, and the reduction was verified under fluoroscopic guidance in AP and lateral views. Sterile scrubbing, painting, and draping were done. An incision of about 8-10 cm was made over the lateral aspect of the thigh, starting from the tip of greater trochanter and extended distally along the length of the femoral shaft. The subcutaneous tissue and tensor fascia lata were incised along the line of the skin incision and retracted. The vastus lateralis was divided. The periosteum over the proximal femur was stripped off. A 4-mm cancellous screw of appropriate length, which acted as a derogation screw, was advanced after drilling. Using a fixed-angle device, a guide wire was passed from the lateral aspect of the proximal femur into the head of the femur. A DHS of appropriate length was advanced over the guide wire after drilling with a triple reamer. A DHS plate of size 4 holes was applied over the screw, and distal locking of the plate was done with cortical screws of appropriate lengths. The position of the plate and screws was verified under fluoroscopic guidance in AP and lateral views. After copious irrigation with normal saline, the surgical wound was closed in layers.

2) Multiple cannulated cancellous technique

Patients were given spinal anesthesia and shifted onto the traction table. Using the Leadbetter technique, the fracture site was reduced and verified under fluoroscopic guidance in AP and lateral views. Sterile scrubbing, painting, and draping were done. Three guide wires were advanced percutaneously from the lateral aspect of the head of femur in a triangular fashion. 6.5-mm cannulated cancellous (CC) screws with washers of appropriate sizes were advanced over the guide wires. Final reduction and fixation were confirmed under fluoroscopic

guidance in AP and lateral views. After 3 failed attempts at closed reduction, open reduction was done.

All patients were given antibiotics for 3 days postoperatively. Bedside sitting, dangling, and quadriceps exercises were initiated with hip range of movements on post-operative Day 1. Patients were kept non-weight-bearing for 6 weeks postoperatively. Post-operative clinical evaluation was done and radiographs obtained on post-operative Day 1 and after 6 weeks, 3 months, 6 months, and 1 year. Gradual weight-bearing was initiated after 6 weeks. At every follow-up, patients were evaluated for any deformity using Harris hip score (HHS). A maximum of 100 points (best possible outcome) covering pain (1 item, 0-44 points), function (7 items, 0-47 points), absence of deformity (1 item, 4 points), and range of motion (2 items, 5 points) were included in this score. The results were classified as follows: Excellent - HHS between 90 and 100; Good – HHS between 80 and 89; Fair – HHS between 70 and 79; and Poor – HHS less than 70.[15]

Outcome measures

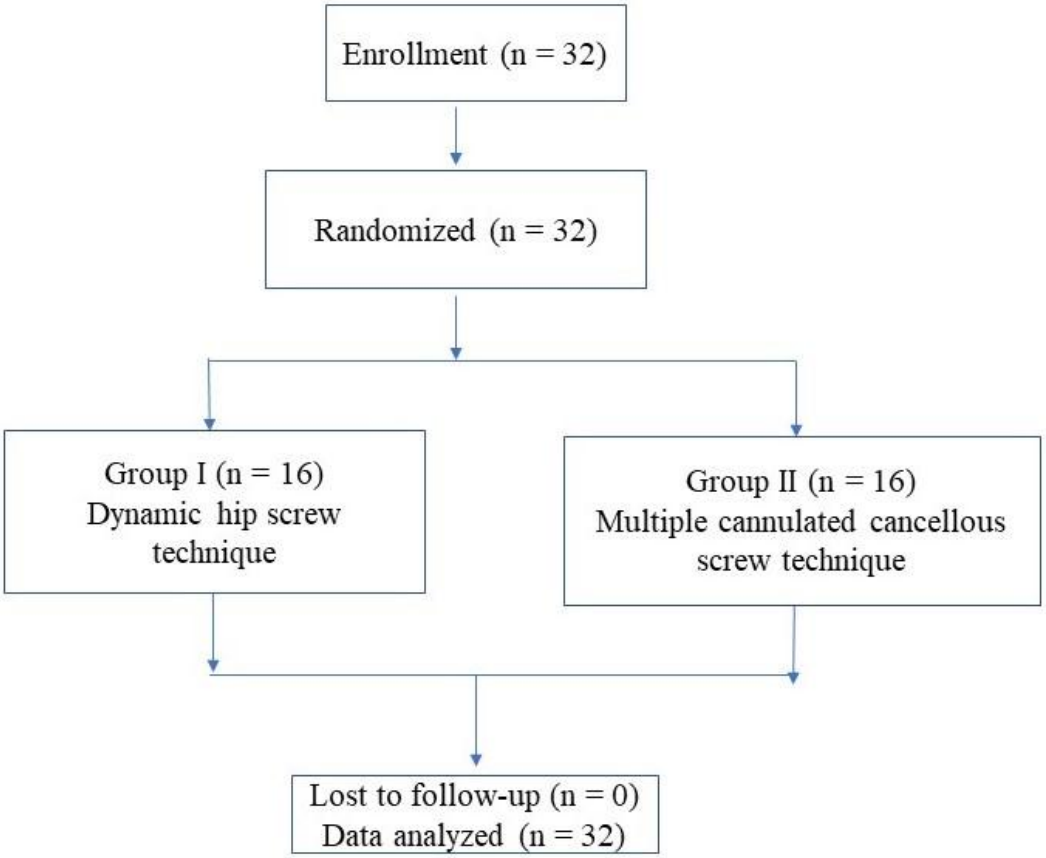
All clinical data including duration of surgery and radiological union was recorded. Complications such as shortening of the femoral neck, screw back-outs, non-union, AVN, etc., were noted. Femoral neck shortening was verified in the vertical plane.

Statistical analysis

Data was analyzed using statistical software R version 4.0.2 and Excel. Categorical variables were represented by frequency tables. Continuous variables were presented as mean ± SD. Chi-square test was employed to check the association between attributes. Two-sample *t*-test was used to compare the mean between two independent groups. *P* value ≤0.05 indicated statistical significance.

Results

The flow of participants through the study is presented in Figure 1.



A total of 32 patients aged 18-50 years were randomized into DHS and MCCS groups with 16 subjects in each. Majority of the patients were males (75%). There was a significant difference ($p<0.001$) in the age-wise distribution of patients between the groups. Table 1 presents the comparison of different variables between the 2 treatment groups.

Table 1
Comparison of demographic variables between groups

Variables	Sub-category	DHS n (%)	MCCS n (%)	Total n (%)	*P* value
Age (years)	>40	15 (93.75)	3 (18.75)	18 (56.25)	<0.001^{MC*}
	≤40	1 (6.25)	13 (81.25)	14 (43.75)	
	Mean±SD	46.38±3.03	38.38±2.33	42.38±4.86	<0.001^{t*}
Gender	Female	6 (37.5)	2 (12.5)	8 (25)	0.2254^{MC}
	Male	10 (62.5)	14 (87.5)	24 (75)	
Side	Left	5 (31.25)	9 (56.25)	14 (43.75)	0.154^{C}
	Right	11 (68.75)	7 (43.75)	18 (56.25)	

C: Chi-square test; DHS: Dynamic hip screw; MC: Chi-square test with Monte Carlo simulation; MCCS: Multiple cannulated cancellous screw; t: Two-sample t-test
** p≤0.05 indicated statistical significance*

The most common mode of injury reported by the patients was high-velocity trauma. The median operative time for the DHS and MCCS groups was 75 mins (60-90 mins range) and 60 mins (50-70 mins range), respectively. The average blood loss was observed to be more in the DHS group (200 mL) compared to the MCCS group (120 mL).

With respect to HHS, 12 out of 16 patients in the DHS group showed excellent results whereas in the MCCS group, only 9 out of 16 subjects showed excellent results. The average time taken for radiological union in the DHS and MCCS groups was 12 weeks and 13 weeks, respectively (Table 2).

Table 2
Harris hip scores of patients

Harris Hip Scores	DHS n (%)	MCCS n (%)
Excellent (90-100)	12 (75)	9 (56.2)
Good (80-89)	3 (18.7)	4 (25)
Fair (70-79)	1 (6.2)	0 (0)
Poor (<70)	0 (0)	3 (18.7)
Total	16 (100)	16 (100)

DHS: Dynamic hip screw; MCCS: Multiple cannulated cancellous screw

In terms of femoral neck shortening, 3 subjects in the MCCS group experienced femoral neck shortening. There was no femoral neck shortening observed in the DHS group. Table 3 presents the details of complications observed in the DHS and MCCS groups. In the DHS group, patients encountered complications like AVN (6.25%), infection (18.75%), and non-union (6.25%). Patients with infection were treated with intravenous antibiotics and daily wound care. In the MCCS group, patients experienced AVN (18.75%), non-union (12.5%), screw back-out, and varus collapse (12.5%). No significant differences in complications were observed between the groups.

Table 3
Complications in the DHS and MCCS groups

Complications	DHS n (%)	MCCS n (%)	Total n (%)	*P* value
AVN	1 (6.25)	3 (18.75)	4 (12.5)	0.0846[MC]
Infection	3 (18.75)	0 (0)	3 (9.38)	
Non-union	1 (6.25)	2 (12.5)	3 (9.38)	
Screw back out	0 (0)	2 (12.5)	2 (6.25)	
Varus collapse	0 (0)	2 (12.5)	2 (6.25)	
None	11 (68.75)	7 (43.75)	18 (56.25)	

AVN: Avascular necrosis; DHS: Dynamic hip screw; MC: Chi-square test with Monte Carlo simulation; MCCS: Multiple cannulated cancellous screws

Discussion

The femoral neck fracture treatment facilitates the patients' return to their routine activities without any delay. In comparison to arthroplasty, internal fixation of femoral neck fractures is cost-effective and provides better results as the native bone tissue is preserved.[16] There is insufficient evidence in literature on the optimal fixation technique for the stabilization of fractures.

The current study showed that the patients' age was important for formulating a treatment plan and that their gender or the affected side did not influence the final outcome. There was a significant difference ($p<0.001$) in the age-wise distribution of patients between the groups. Studies conducted by Al-Kelabi et al and Siavashi et al reported no significant differences in the distribution of age between the groups.[17],[18] Physiological age rather than chronological age could be an important factor in deciding the modality of treatment wherein, the quality of bone decides the strength of the implant and rate of failure.[16]

In the current study, the median operative time in the DHS group was more as compared to the MCCS group. However, the difference was statistically insignificant. Similarly, Al-Kelabi also reported more operative time for the DHS group (80 mins [range 65-150 mins]) as compared to the MCCS group (75 mins [range 60-130 mins]) with no statistical significance between the groups.[17] The reason for this difference in the duration of surgery could be that open reduction was done in all the cases in the DHS group whereas, in the MCCS group, the treatment was done by closed reduction and fixation.

With regard to the average blood loss, the current study reported more average blood loss in the DHS group (200 mL) as compared to the MCCS group (120 mL). Singh et al also reported similar findings with more average blood loss in the DHS group (206 mL) than in the MCCS group (92 mL).[19] The reason for increased blood loss in the DHS group could be attributed to the length of the incision which was more than that in the MCCS group and also a greater amount of soft tissue stripping in the DHS group.[20]

In terms of HHS, the DHS group in our study showed excellent results (75%) as compared to MCCS group (56.2%) which is in accordance with the study conducted by Lakhani et al, wherein DHS demonstrated excellent results (61.3%) as compared to cannulated cancellous screws (25.8%).[21] Similarly, another study also reported higher HHS scores in the DHS group (88.4%) as compared to MCCS (87.5%) at one-year duration.[22] These results showed that DHS is not only stable but achieves better compression across the fracture, allowing early union and mobilization. The rate of non-union in the present study was 6.25% in the DHS group in comparison to 12.5% in MCCS group. However, these results were not statistically significant. Singh et al reported the rate of non-union as 9.5% in DHS group versus 13.6% in MCCS group. Another study conducted by Lakhani et al reported 50% non-union in MCCS group, whereas none of the patients in the DHS group reported non-union. The risk factors for non-union could be delay in surgery, early loss of reduction, and convergent screw fixation.

With regard to complications in the current study, 43.7% of patients in the DHS and MCCS groups experienced complications. However, the difference was statistically insignificant. Similarly, Al-Kalebi et al reported 39.1% complications in both DHS and MCCS groups, and that the difference was insignificant.[17] Borgohain et al also reported more complications in the MCCS group (31.2%) in comparison to DHS (12.5%) which is in line with our study.[22] These study results demonstrated that fracture fixation with DHS was more stable and had minimum complications as compared to MCCS.

Overall, a positive clinical outcome following the use of DHS was noted in this study. Femoral neck fracture fixation with DHS was found to be more reliable than with MCCS. However, the small sample size used in the current study could be a drawback for effective comparison and interpretation of results. Hence, further studies using a larger sample size are warranted to provide a stronger evidence for effective clinical treatment of femoral neck fractures.

Conclusion

Dynamic hip screws can be a better implant than MCCS in the management of femoral neck fractures with respect to clinical outcomes. However, the complication rate proved no relation to the implant selection. Hence, larger, multicenter studies are warranted for further evaluation of such procedures to consolidate these results.

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