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COMPARATIVE STUDY OF INTERNAL FIXATION BY DIFFERENT IMPLANTS IN DISPLACED FRACTURED NECK OF FEMUR IN ADULTS

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ABSTRACT: Treatment of fracture neck of the femur depends mainly upon the viability of the head of the femur and internal fixation remains the method of choice if head is viable. A total of 61 patients satisfying the inclusion criteria were allotted to the two treatment groups, either a cannulated cancellous screw system(CCS) or a dynamic hip screw with antirotation screw (DHS-AS).The two procedures were compared for the time taken for union and complications like osteonecrosis and non-union. Follow-up was done at 6 weeks, 3 months, 6 months and then 6 monthly for a maximum of 2 years. Rate of osteonecrosis was comparable for both procedures but non-union was significantly higher in patients treated with CCS and those with Pauwel's type III fractures. By 6 months 83.61% of patients had achieved union. For CCS cases it was 70.97% and for DHS-AS it was 96.67% at 6 months follow up.

Key words: Fracture, Neck of femur, Cannulated cancellous screw, Dynamic hip screw, Anti-rotation screw.

INTRODUCTION

Fracture neck of femur is uncommon in patients under 60 years of age and accounts for only 3% of all hip fractures (Robinson *et al.* 1995). In younger adults the injuries are often the result of high energy trauma (Zeetterberg *et al.* 1982, Farook *et al.* 2005). Following fracture neck of femur the blood supply to the femoral head may be impaired or entirely lacking, for this reason osteonecrosis and later degenerative changes of the femoral head or non-union often follow femoral neck fractures.

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Results after this injury apparently depend on mainly three factors. Primarily, the extent of the injury, such as the amount of displacement, the amount of comminution and whether the circulation has been disturbed. It also depends on the adequacy of the reduction and the adequacy of fixation.

Internal fixation remains the method of choice if head is viable especially in younger patients.

There are various methods of internal fixation but the usual choice is either a cannulated cancellous screw system or a dynamic hip screw with antirotation screw.

The internal trabecular system of the femoral head was described by Ward (1838).The orientation is along lines of stress, and thicker lines come from the calcar and rise superiorly into the weight-bearing dome of the femoral head. Forces acting in this arcade are largely compressive. Lesser trabecular patterns extend from the inferior region of the foveal area across the head and superior portion of the femoral neck into the trochanter and lateral cortex.

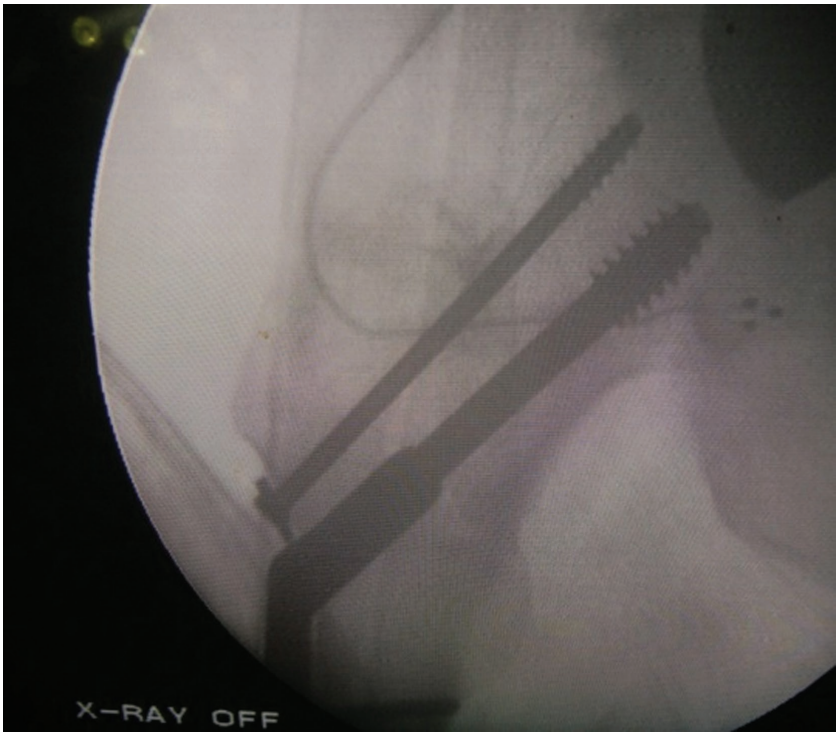


Fig.1: Dynamic hip screw with anti-rotation screw.

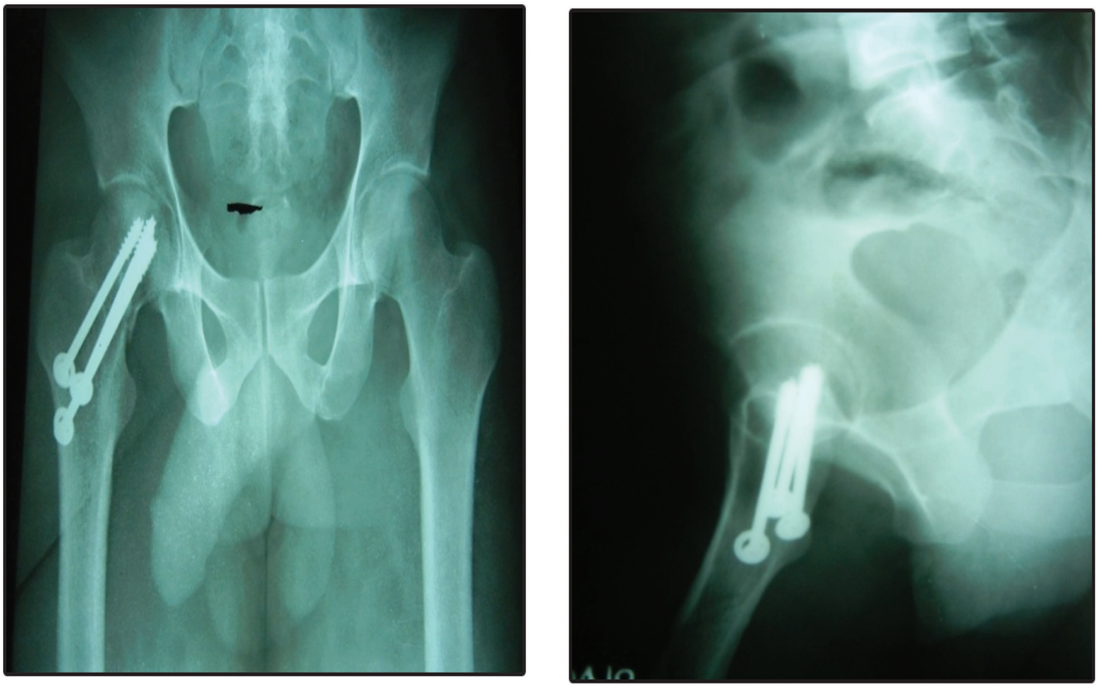


Fig.2: Cannulated cancellous screw system.

According to Harty (1957) and Griffin (1982), the calcarfemorale is a dense vertical plate of bone extending from the postero-medial portion of the femoral shaft under the lesser trochanter and radiating lateral to the greater trochanter, reinforcing the femoral neck posteroinferiorly. The calcarfemorale is thicker medially and gradually thins as it passes laterally (Griffin 1982, Manninger *et al.* 1985, Manninger *et al.* 1989).

The hip joint capsule is a strong fibrous structure that encloses the femoral head and most of its neck. The capsule is attached anteriorly at the intertrochanteric line; posteriorly, however, the lateral half of the femoral neck is outside the capsule (Pankovich 1975). That portion of the neck that is within the capsule has essentially no cambium layer in its fibrous covering to participate in peripheral callus formation during the healing process (Pankovich 1975).Therefore, healing in the femoral neck area is dependent on endosteal union alone.

Unless the fracture fragments are impacted, synovial fluid can lyse blood clot formation and thereby destroy another mode of secondary healing by preventing the formation of cells and scaffolding that would allow for vascular invasion of the femoral head. For all practical purposes, the femoral head is rendered largely avascular by a displaced femoral neck fracture(Sevitt and Thompson 1965). Fracture union can occur despite an avascular fragment, although the incidence of non-union is increased (Sevitt and Thompson 1965). However, even with optimum treatment, signs of aseptic necrosis and later segmental collapse can still occur.

Crock (1980) described the arteries of the proximal end of the femur in three groups: (a)an extra capsular arterial ring located at the base of the femoral neck; (b)ascending cervical branches of the extracapsular arterial ring on the surface of the femoral neck; and (c)the arteries of the ligamentum teres femoris.

Trueta and Harrison(1953) reported that the femoral epiphyseal blood supply in the adults is mainly from lateral epiphyseal arteries that enter the head postero-superiorly and secondarily from the medial epiphyseal artery entering through the ligamentum teres femoris. Sevitt and Thompson (1965) also demonstrated that the superior retinacular and lateral epiphyseal vessels were responsible for most femoral head circulation. The vessels in the ligamentum teres femoris (medial epiphyseal) were not so important in most femoral heads, being responsible only for a small area of subsynovial circulation.

When a femoral neck fracture occurs, the intraosseous cervical vessels are disrupted. Femoral head nutrition is then dependent on remaining retinacular vessels and those functioning vessels in the ligamentum teres.

The femoral head has been recognized for some time to be avascular, either partially or totally, in most cases after displaced femoral neck fractures (Treat and Harrison 1953). Prompt reduction and stable fracture fixation are recommended for restoration of vascular supply to the head of femur.

Several factors affect the strength of femoral neck fixation using multiple screws.

Factors that do increase the strength of this type of fixation include a more horizontal fracture line with respect to the long axes of the screws (Edwards *et al.* 1985). Placement of the screws in areas of greater femoral head bone density (Swiontkowski *et al.* 1987, Stankewitz *et al.* 1996), fractures with less comminution (Rubin *et al.* 1981, Stankewitzet *et al.* 1996). and a shorter moment arm for the joint load (shorter distance from the center of the femoral head to the fracture line (Stankewitz *et al.* 1996).

The most important factor has been found to be the quality of the reduction due to the importance of cortical buttressing in reducing fracture displacement (Spangler *et al.* 2001).

A sliding device with a screw-plate angle closest to the combined force vector allows optimum sliding and impaction. The closer the nail plate angle to the resultant vector of the forces across the hip, the more force is available to assist impaction. The ideal position for the nail or screw in the femoral head is the point of coalescence of the tension and compression trabeculae, which results in a dense pattern of cancellous bone in the centre of the head within five millimeters of the sub-chondral bone (Kyle *et al.* 2005).

The aim of this study is to compare the results of internal fixation by multiple cannulated cancellous screws and dynamic hip screw with antirotation screw in fracture of the neck of the femur.

The objectives of the study are as follows:

a) To compare rate of non-union.
b) To compare rate of avascular necrosis.
c) To compare time taken for union.

MATERIALS AND METHODS

Study area – R. G. Kar Medical College and Hospital, Kolkata, West Bengal, India.

Study population - The source of patients are those having fractures of neck of the femur attending either emergency or outpatient department.

Study period – January 2011 to March 2013.

Inclusion criteria -

(i) Closed displaced (Garden type III and IV) fractures of neck of the femur.

(ii) Age of the patients between 18 to 60 years.

(iii) Duration of fracture less than 3 weeks.

(iv) Minimum follow up of 6 months.

Exclusion criteria –

a) Patients age less than 18 years and more than 60 years.

b) Fracture more than 3 weeks duration.

c) Hip joint affected by pre-existing disease (ankylosingspondylitis, rheumatoidarthritis etc).

d) Pathological fracture.

e) Open fracture.

f) Basicervical fractures.

g) Undisplacedintra capsular fractures.

h) Polytrauma patients and patients who required intensive care.

Sample design: Purposive sampling where all cases are allotted alternately in each study group.

Study design: Analytical prospective study.

61 consecutive patients of displaced fracture neck of the femur between 18 to 60 years age and less than three weeks duration were treated. Thirty one patients were treated by cannulated cancellous screw (CCS) and thirty patients were treated by dynamic hip screw with anti-rotation screw (DHS-AS).

Intra-operative radiographs were taken to verify the position of the fracture on both the AP and Lateral views. We accepted reductions according to Garden Alignment Index. Open reduction was not needed in any case.

Patients were followed up at 6 weeks, 3 months, 6 months and 6 monthly thereafter for a maximum of 2 years. Weight bearing was allowed on the basis of the healing seen on routine radiographs at follow up and weight bearing varied depending on the stability of the construct. A whole body bone scan was done at 6 months for the early detection of any osteonecrotic changes.

Harris hip score was evaluated at 6 months intervals.

RESULTS AND DISCUSSION

Sixty one cases had been followed up and compared, the minimum period of follow up being 6 months.

Osteonecrosis developed in 23% of CCS patients and 27% of DHS patients whereas overall rate was 24.59%.

Rate of nonunion was 29% in CCS and only 3% in DHS patients while overall rate of nonunion was 16.39%.

Fractures of the femoral neck continue to remain an unsolved mystery. While there has not been universal acceptance of any of its classifications, the same can be told about its treatment modalities.The most widely accepted classification for the femoral neck fractures is the Garden classification (Zlowodzki *et al*. 2005). However dividing the fractures into undisplaced (Garden I & II) and displaced (Garden III & IV) varieties, helps us to have a distinct idea for the treatment, since the undisplaced varieties in general have a good prognosis while the displaced fractures still remain a challenge (John Keating 2010). In our study, we have evaluated the displaced fractures of Garden (types III and IV).

Pauwels' classification pertains to the angle made by the fracture line with the horizontal, the greater the angle the worse the prognosis (John Keating 2010). In our series of patients Pauwels' classification has better relevance owing to the younger age profile of our patients, who have a vertical fracture line as compared to the elderly with transverse fracture lines (John Keating

Table 1: Age distribution (n =61).

Age distribution (years)	CCS(n_1=31)	DHS-AS(n_2=30)
18-30	6	6
31-40	8	5
41-50	12	12
51-60	5	7
Total	**31**	**30**
t = 0.434 df = 59 p=0.666		

Table 2: Sex distribution (n=61).

Procedure	Male	Female
CCS (n_1 = 31)	18	n
DHS-AS(n_2= 30)	21	9
Total	**39**	**20**
	c^2 = 0.94	p=0.3317

Table 3: Garden type distribution (n =61).

Procedure	Type III	Type IV
CCS(n_1 = 31)	12	19
DHS- AS(n_2= 30)	11	19
Total	**23**	**38**

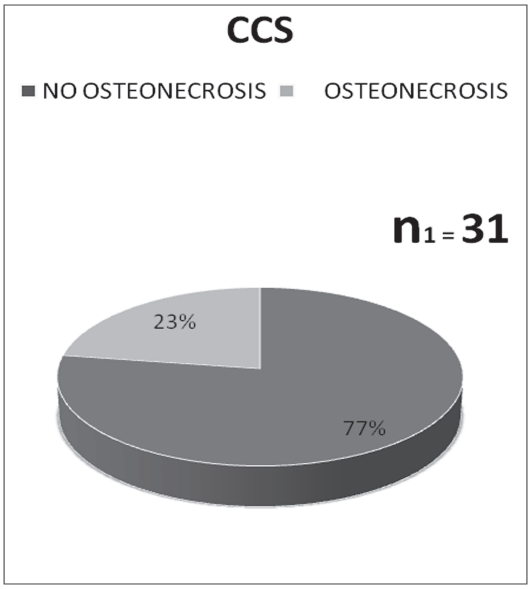
Table 4: Pauwels' type distribution (n =61).

Procedure	Type I	Type II	Type III
CCS	7	10	14
DHS-AS	5	9	16
Total	**12**	**19**	**30**

Table 5: Time interval to operation distribution study

Delay in operation (in number of days)	CCS	DHS-AS
0-7	14	n
8-14	10	9
15-21	7	8
t = 0.342	df = **59**	**p = 0.734**

Diagram: Distribution of osteonecrosis (n =61).



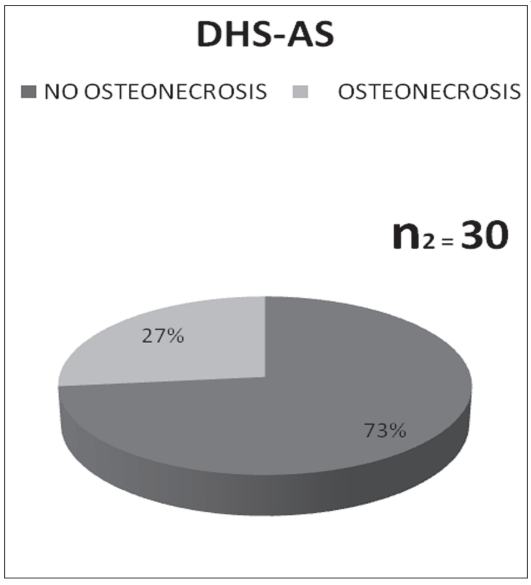


Table 6: Distribution of non-union (n =61).

Procedure	Union	Nonunion
CCS	22	9
DHS-AS	29	1
Total	51	10
χ^2 = **5.592**	df = **1**	**p= 0.0180**

Table 7: Ability of weight bearing with time.

Time since surgery	Partial	Full	Union
6 Weeks	33		
12 Weeks		42	
6 Months			51

Table 8: Distribution of patients developing osteonecrosis versus delay in operation.

Procedure	1-7 days	8-14 days	15-21 days
CHS	2 (14.28%)	2(20.00%)	3 (42.80%)
DHS-AS	2(15.40%)	2(22.00%)	4(50.00%)
Total	**4**	**4**	**7**

Table 9: Distribution of patients developing nonunionversus delay in operation.

Procedure	1-7 days	8-14 days	15-21 days
CHS	2(14.28%)	3(30.00%)	4(40.57%)
DHS-AS	0	0	1(12.50%)
Total	**2**	**3**	**5**

Table 10: Harris hip score (n=61).

Procedure	Excellent	Good	Fair	Poor
CCS	13	2	7	9
DHS-AS	14	6	7	3
Total	**27**	**8**	**14**	**12**

2010).

In spite of our best efforts like urgent internal fixation with anatomical reduction and the most stringent post-operative care, the anatomy, bio-mechanics and patho-physiology of these fractures is such that invariably there will be complications like osteonecrosis and non-union.

Long term follow up studies reveal no significant difference in outcome with regards to time taken to intervene. However most agree that an urgent intervention should be the norm. Prompt reduction of the displacement possibly may open some of the retinacular vessels that are temporarily closed by kinking or stretching and rigid fixation may permit reestablishment of some vascular continuity that otherwise might not be preserved if reduction and fixation are delayed (Lu-Yao *et al.* 1994).

Barnes *et al.*(1976) found that time elapsed from trauma to surgery had no influence on the rate of avascular necrosis and non-union in patients treated with reduction and fixation up to 7 days after injury. Experimental studies have shown that osteocyte cell death may not be complete up to 2 - 3 weeks of the fracture. In our study we have included patients who were treated within 3 weeks of injury.

In a meta-analysis (Fogaglo *et al.* 2004) overall rate of osteonecrosis following internal fixation (CCS, DHS-AS, DHS without

Table 11: A comparison of rate of osteonecrosis (%).

Fracture variable	CCS	DHS-AS
PAUWELS'I	14.28	20
PAUWELS'II	20	11.11
PAWELS'III	28.57	37.5
GARDEN III	8.33	18.18
GARDEN IV	31.57	31.57
Operation within 1st week	14.28	15.4
Operation between 1st& 2nd week	20.00	22.00
Operation between 2nd& 3rd week	42.8	50.00

Table 12: A comparison of rate of nonunion.

Fracture variable	CCS	DHS-AS
PAUWELS' I	0%	0%
PAUWELS' II	10%	0%
PAUWELS' III	57.14%	6.25%
GARDEN III	25%	0%
GARDEN IV	32%	5%
Operation within 1st week	14.28%	0%
Operation in 2nd week	30%	0%
Operation in 3rd week	57%	12.5%

antirotation screw) was 24.2%with a range of 2.5% to 40.9%. In our study overall rate of osteonecrosis was 24.59%.while in CCS it was 23% and in DHS-AS it was 27%.

In our study that rate of osteonecrosis for Garden IV fracture was same for both procedures. While for Pauwels' type II DHS – AS has a slightly better outcome for osteonecrosis, for all other fractures CCS has lower rate of osteonecrosis.

Meta-analysis by Fogaglo *et al* (2004), rate of non-union varied from 0% to 7.2% with an average of 3.6%. In our study non-union for CCS and DHS-AS was 29.03% and 3.33% respectively overall being 16.39%.

Non-union rate is less in DHS-AS when compared to CCS and is statistically significant (p=0.018). Overall results of DHS-AS were better than CCS for achieving union but only in pauwels' type III this was statistically significant (p=0.0084).

Weight bearing was allowed from first post-operative day with toe touch crutch walking and partial weight bearing was begun when radiographic evidence of healing was seen at 6 weeks or later. Full weight bearing was allowed not before 12 weeks and only when union was evident radiographically and clinically.

Full weight bearing was allowed for those patients who showed signs of union at 12 weeks. However a case was considered to be non-union only when 6 months were elapsed without evidence of union clinical and radiological.

Partial weight bearing was given to 54.09% of patients at 6 weeks, while full weight bearing was possible in 68.85% patients at 3 months and by 6 months 83.61% patients had achieved union. For CCS cases it was 70.97% and for DHS-AS it was 96.67% at 6 months follow up.

Harris Hip Score evaluation shows excellent results for 41.94% and poor results for 29.03% of CCS cases. Whereas in DHS-AS it is 46.66% excellent and 10% poor results (Harris WH 1969).

CONCLUSION

Our study was a comparative analysis of the two treatment modalities for displaced fracture neck of femur in adults less than 60 years of age. Majority of our patients belonged to Pauwels' type III fractures which classically had been associated with worse prognosis. Though earliest possible intervention was tried there was an inevitable delaywhich may have contributed to the slightly poorer outcome in those patients treated after one week.

DHS-AS has a distinct and significant advantage over CHS in preventing non-union with the difference being more evident in Pauwels' type III fractures.

In respect of osteonecrosis there was no significant advantage of one over the other. However there was higher incidence in DHS-AS.

The inherent instability of vertical fractures and greater shearing forces working at the fracture site are managed optimally by the compressive forces provided by DHS-AS. The higher rate of reported complications for DHS in available literature may have been due to not using an anti-rotation screw.We have included the anti-rotation screw in our treatment regime and found it to be useful.

To conclude we recommend the use of DHS-AS over CHS for displaced fracture of neck of femur especially the ones with vertical fracture lines.

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