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WITH REGARDS TO THE CLINICO-FUNCTIONAL OUTCOMES, IN BETWEEN FQPP OR BDSF TECHNIQUE, WHICH IS SUPERIOR, AS A CANCELLOUS SCREW FIXATION OPTION, FOR FRACTURE NECK OF FEMUR.

Orthopaedics

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ABSTRACT

Fracture Neck of Femur are common and one among the most challenging Orthopaedic trauma cases. Many a factors like age, time elapsed after occurrence of injury, presence of other musculo-skeletal trauma and presence of other co-morbid conditions, are all to be taken into account, before embarking on any surgical intervention. Given the precarious blood supply of the femoral head, AVN of the femoral head is a significant complication in the displaced fractures. Among the various classification systems available, the Garden classification is still in vogue, as highlighted by Guyton J.L et al; (1). The purpose of this prospective study, is to establish the superiority or otherwise of the 'Four Quadrant Peripheral Parallel (FQPP) Screw Fixation" technique, over the "Biplanar Double Support Screw Fixation (BDSF)" technique, when opting for multiple percutaneous cancellous screw fixation, for fracture neck of femur. The age group in our study included patients from 26 years to 55 years and had a total of 18 patients, who were recruited in between March 2018 to February 2020. Of these 18 patients, 9 patients were treated by the FQPP technique and another 9 patients by the BDSF technique. All cases were followed-up for at least 1 year (range: 12 to 35 months, mean 18 months). Evaluation was done by Harris Hip Score (HHS) (2). In the FQPP group, 55.56% (n=5) patients had good to excellent results, 22.22% (n=2) patients had fair and 22.22% (n=2) patients had poor outcomes. In the BDSF group 66.67% (n=6) patients had good to excellent results, 22.22% (n=2) patients had fair and 11.11% (n=1) patient had poor outcome. Thus, the results were only just marginally better for the BDSF group, in comparison to the FQPP group and hence, no substantial deductions could be made favoring the superiority of one fixation type over the other.

KEYWORDS

Fracture Neck of Femur, Four Quadrant Parallel Peripheral Screw Fixation, Biplanar Double Supported Screw Fixation, Harris Hip Score.

INTRODUCTION:

One among the common, yet very challenging Orthopaedic traumatic injury is the intra-capsular variant of the fracture neck of femur [Fig: 1 (a)]. While in the elderly, a typical neck of femur fracture results as a consequence of fragility fracture associated with osteoporosis, in the young age group, on the other hand, it is as a result of high energy trauma mechanics and is usually accompanied by other musculo-skeletal injuries. The complications of intra-capsular fracture neck of femur are those primarily related to the precarious blood supply of the head [Fig. 1 (b) (c) (d)], which invariably gets disrupted when a fracture in this zone occurs. Anatomically the proximal epiphysis of the femur gets closed by age of around sixteen years and we have a skeletally mature shaft-neck angle of about 130 ± 7^0 and an ante-version angle of 10 ± 7^0. Anteriorly, we have the Bigelow ligament and the Pubo-Femoral ligament. Posteriorly, we have here the Ischio-femoral ligament. An osseous plate plate oriented vertically from the femoral shaft's postero-medial aspect and directed towards the greater trochanter, is the Calcar femorale and its basic purpose is to reinforce femoral neck posteriorly [Fig. 2].

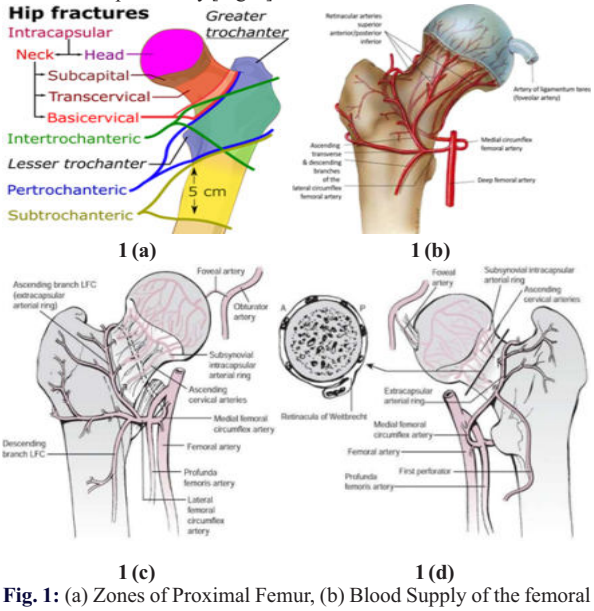


Fig. 1: (a) Zones of Proximal Femur, (b) Blood Supply of the femoral head, (c) Extracapsular Arterial Ring, (d) Retinacula of Weitbrecht

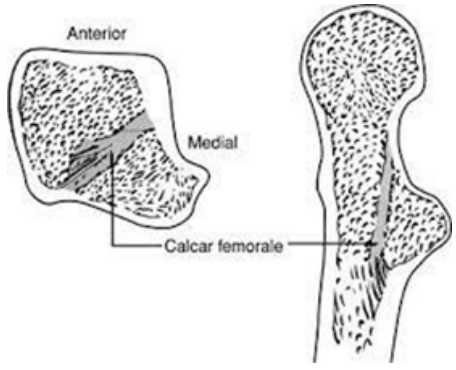
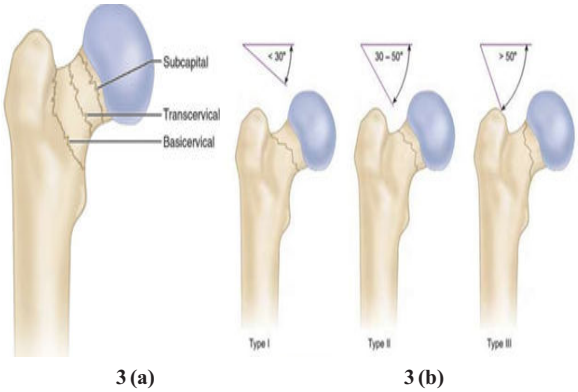


Fig. 2: Calcar Femorale

In the interpretation of treatment of trauma in modern orthopaedics, these intra-capsular fracture across all age groups needs to be surgically intervened upon, except in the pediatric undisplaced fracture or in the moribund patients who are unfit for surgical intervention. Classifications of fracture neck of femur till date banks on three pillars, the Anatomical one based on fracture line [Fig. 3 (a)], two Pauwels based on angle of fracture line to the horizontal plane [Fig. 3 (b)], and the third is the Garden classification which is based on fracture displacement factor [Fig. 3 (c)].



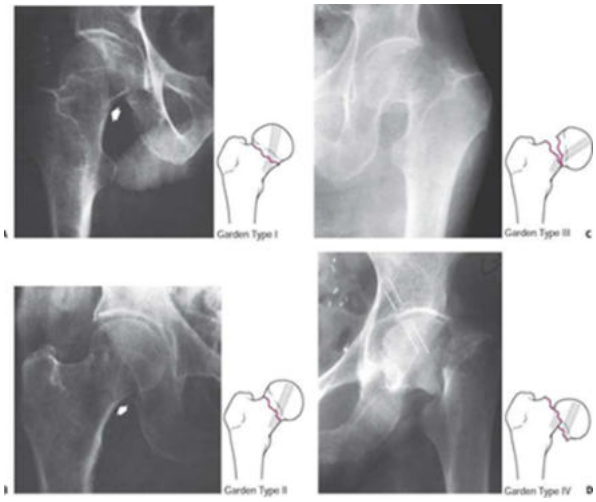


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Fig. 3: (a) Fracture neck of femur based on Anatomical classification, (b) Pauwels classification for Fracture neck of femur, © Garden's classification for Fracture neck of femur

Only in those patients aged below 60 years, does modern orthopaedics consider CRIF or ORIF either by DHS (Dynamic Hip Screw) or CCS (Cannulated Cancellous Screw) as an option. For those, aged above 60 years, depending on the status of the calcar options are THA (Total Hip Arthroplasty), BPHA (Bipolar Hemiarthroplasty) or HRA (Hemi-Replacement Arthroplasty). Conservative treatment is "out of vogue". In this scenario we have included in this study, fracture neck of femur, in the age group of 26 years to 55 years, so that the factor of osteoporosis is not a pre-dominant factor and we get to have a good to a reasonably good Calcar femorale. This prospective study was framed from March 2018 to February 2021 (2 years of recruitment, and at least 1 year of follow-up). The inclusion criteria included Garden Stage I to III and the study was to compare Biplanar Double Support Screw Fixation (BDSF) methodology versus the Four Quadrant Peripheral Parallel (FQPP) screw fixation, for the not so grossly displaced femoral neck fractures of the skeletally mature adult.

MATERIALS AND METHODS:

This was a prospective study conducted at the Department of Orthopaedics Trichy SRM Medical College Hospital and Research Centre, Trichy, Tamil Nadu from March 2018 to February 2021 (Two years of recruitment which stopped in February 2020 and at least One year of follow-up which continued till February 2021).

Inclusion Criteria:

(a) Patients of both sex, diagnosed as fracture neck of femur, aged between 26 years to 55 years.
(b) Garden Stage I to III neck of femur fracture only.

Exclusion Criteria:

(a) Fracture Neck of femur, later than 6 days (144 hours), after the incidence of injury.
(b) Poly-trauma patients.
(c) Underlying metabolic or neurological disorder.
(d) Patients not conforming to our age group criteria.
(e) Patients on anti-epileptics, smokers and other serious uncontrolled co-morbid conditions.
(f) Immuno-compromised patients, RA patients and those with previous injury to the ipsilateral proximal femur.

INTRA-OP AND POST-OP MODALITIES:

All cases were done under appropriate anesthesia, under C-Arm guidance. Surgical intervention was carried out as a closed reduction and percutaneous cancellous screw fixation either by the "Four Quadrant Peripheral Parallel" (FQPP) screw fixation technique or by the "Biplanar Double Support Screw Fixation" (BDSF) technique, was carried out.

IV antibiotics Ceftriaxone plus Sulbactam was given for 72 hours. Post-op bed side physiotherapy - Gentle hip exercises and static quadriceps exercises was initiated on POD-2. Non weight bearing with walker mobilization was started on POD-3. Suture removal done on POD-12. Toe Touch mobilization with walker was initiated from 6th week onwards and Partial weight bearing walker mobilization was permitted from 8th week onwards. Full weight bearing mobilization was permitted only from 12th week of surgical intervention.

Routine clinico-functional and radiological follow-up were done at weeks 6,8 and 12. Thereafter cases were followed-up at every 2 months interval. At the end of 12th month Harris Hip Score (2) assessment was done for cases, which went on for union or those which recorded complications requiring re-surgical interventions. Data so compiled was organized and observations tabulated and deduced.

RESULTS:

In keeping with our inclusion criteria, in the two years of recruitment of patients from March 2018 to February 2020, we enrolled 18 patients, 9 patients were treated by the "Four Quadrant Peripheral Parallel" (FQPP) fixation technique and the other 9 patients were treated by the "Biplanar Double Support Screw Fixation" (BDSF) technique.

With regard, to the age and sex demographics, the maximum number of patients 44.44% (n=8) were in the age category of 46 to 55 years, this was followed by 38.89% (n=7) in the 36-45 years age group and 16.67% (n=3) in the 26 to 35 years age group respectively. There were in all 55.56% (n=10) patients, who were male subjects and 44.44% (n=8) patients, who were female subjects. (Table-1).

Table-1: Age And Sex Demographics Distribution:

Age Group In Years	FQPP			BDSF			TOTAL 'n' (%age)
	Male	Female	n_1	Male	Female	n_2	
26-35	2	0	2	1	0	1	3 (16.67%)
36-45	2	1	3	2	2	4	7 (38.89%)
46-55	2	2	4	1	3	4	8 (44.44%)
TOTAL	6	3	9	4	5	9	18 (100%)

With regard, to the anatomical location of the fracture was concerned 50% (n=9) were of the transcervical type, 27.78% (n=5) were of the subcapital type and the remaining 22.22% (n=4) were of the basicervical type. Thus, the maximum cases were of the transcervical anatomical type. (Table-2).

Table-2: Anatomical Location Wise Fracture Distribution, In The Two Groups:

Fracture Level	FQPP n_1	BDSF n_2	TOTAL 'n' (%age)
SUBCAPITAL	3	2	5 (27.78%)
TRANSCERVICAL	4	5	9 (50.00%)
BASICERVICAL	2	2	4 (22.22%)
TOTAL	9	9	18 (100%)

With regard, to the Pauwels angle based distribution of cases, 61.11% (n=11) were of the type II, 22.22% (n=4) were of the type I and the remaining 16.67% (n=3) were of the type III category. Thus, the maximum cases were of the type II category. (Table-3).

Table-3: Pauwels Angle Wise Distribution, In The Two Groups:

Pauwels Classification	FQPP n_1	BDSF n_2	TOTAL 'n' (%age)
TYPE I (ANGLE LESS THAN 30^0)	2	2	4 (22.22%)
TYPE II (ANGLE BETWEEN 30^0-50^0)	6	5	11 (61.11%)
TYPE III (ANGLE MORE THAN 50^0)	1	2	3 (16.67%)
TOTAL	9	9	18 (100%)

With regard, to Garden staging, 50% (n=9) were of Garden stage II, 27.78% (n=5) were of Garden stage III and the remaining 22.22% (n=4) were of Garden stage I fractures. Thus, the maximum cases were of the Garden stage II category. (Table-4).

Table-4: Garden Staging Wise Distribution, In The Two Groups:

Garden Stage	FQPP n_1	BDSF n_2	TOTAL 'n' (%age)
I	2	2	4 (22.22%)
II	5	4	9 (50.00%)

III	2	3	5 (27.78%)
TOTAL	9	9	18 (100%)

With regard, to Singh's Index wise distribution of cases, Grade 6 comprised of 33.33% (n=6) cases, Grade 5 and 4 comprised of 27.78% (n=5) respectively and Grade 3 comprised of 11.11% (n=2) cases. Thus, the maximum cases were of Singh's Index Grade 6. There were no patients belonging to Grade 2 or Grade 1 of the Singh's Index. (Table-5).

Table-5: Singh's Index Wise Distribution, In The Two Groups:

GRADE	FQPP n_1	BDSF n_2	TOTAL 'n' (%age)
GRADE 6	3	3	6 (33.33%)
GRADE 5	3	2	5 (27.78%)
GRADE 4	2	3	5 (27.78%)
GRADE 3	1	1	2 (11.11%)
GRADE 2	0	0	0
GRADE 1	0	0	0
TOTAL	9	9	18 (100%)

With regard, to the time elapsed from injury to the surgical intervention, 50% (n=9) cases were operated upon by day 1 to 2, 33.33% (n=6) cases were operated upon by day 3 to 4, and the 16.67% (n=3) cases were operated upon day 5 to 6. (Table-6).

Table-6: Time Interval in Days Between Injury and Surgery:

Days From Injury	FQPP n_1	BDSF n_2	TOTAL 'n' (%age)
1 TO 2	4	5	9 (50.00%)
3 TO 4	3	3	6 (33.33%)
5 TO 6	2	1	3 (16.67%)
TOTAL	9	9	18 (100%)

With regard, to complications encountered, there was 1 case of superficial infection in FQPP group which settled with dressings and IV antibiotics. There were 1 case in both the FQPP and BDSF group which had hardware related issues like loosening and back-out but went on to sound union. There were 2 cases in the FQPP and 1 case in BDSF group, that went on to non-union and these very same cases, also progressed to Avascular necrosis, which were addressed by doing Total Hip Arthroplasty (THA). (Table-7). Incidentally, the three cases in question belonged to the age group of 46 to 55 years, of fracture Garden stage III and surgically primarily intervened upon after 3 days of injury.

Table-7: Complication Distribution In The Two Groups:

COMPLICATION	FQPP n_1	BDSF n_2	TOTAL 'n' (%age)
SUPERFICIAL INFECTION	1	0	1 (5.55%)
HARDWARE RELATED	1	1	2 (11.11%)
NON-UNION	2	1	3 (16.67%)
AVN	2	1	3 (16.67%)

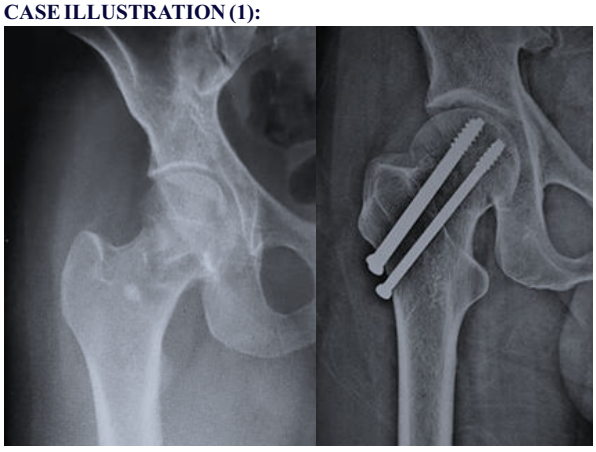
All cases were followed-up for at least 12 months (range: 12 to 35 months, mean 18 months).

The Harris Hip Score (HHS) (2) evaluation was done at 12th month follow-up. In the FQPP group, 55.56% (n=5) patients had good to excellent results, 22.22% (n=2) patients had fair and 22.22% (n=2) patients had poor outcomes. In the BDSF group 66.67% (n=6) patients had good to excellent results, 22.22% (n=2) patients had fair and 11.11% (n=1) patient had poor outcome. Thus, the results were only just marginally better for the BDSF group, in comparison to the FQPP group and hence no substantial deductions could be made favouring the superiority of one fixation type over the other. Overall, combining the two procedures (viz; FQPP and BDSF), we had 61.11% (n=11) patients in the excellent to good category of HSS, 22.22% (n=4) patients in the fair and 16.67% (n=3) patients in the poor category. (Table-8).

Table-8: Outcome HHS Grading Wise Distribution in the two groups at the 12th month follow-up:

HHS GRADING (WITH SCORE RANGE)	FQPP n_1	BDSF n_2	TOTAL 'n' (%age)
EXCELLENT (90 TO 100)	2	4	6 (33.33%)
GOOD (80 TO 89)	3	2	5 (27.78%)
FAIR (70 TO 79)	2	2	4 (22.22%)
POOR (LESS THAN 70)	2	1	3 (16.67%)
TOTAL	9	9	18 (100%)

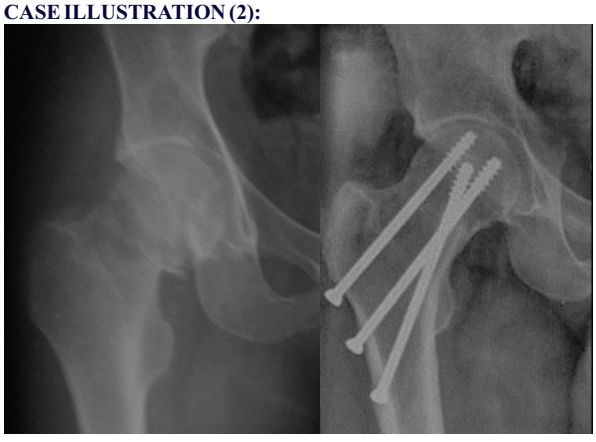
CASE ILLUSTRATION (1):



4 (a) 4 (b)

Fig 4: FQPP Screw Fixation Technique - (a) Pre-op X-ray, (b) 12th month Post-op follow-up X-ray depicting sound union.

CASE ILLUSTRATION (2):



5 (a) 5 (b)

Fig 5: BDSF Technique - (a) Pre-op X-ray, (b) 12th month Post-op follow-up X-ray depicting sound union.

DISCUSSION:

Fractures of the proximal femur, according to Fox K.M et al; (3) are a major musculo-skeletal cause of hospitalization. Koval K.J et al; (4) states that these fractures of the femoral neck, occur between the inter-trochanteric region and the femoral head. Guyton J.L et al; (1) states that these fractures are prone to non-union as the synovial fluid disrupts the natural fracture healing process. Evans P.J et al; (5) states that invariably there is disruption of the lateral ascending cervical branches belonging to the circumflex medial femoral artery and is a causative risk factor for AVN of the head of femur. Ravi Mittal et al; (6) further states that the periosteal cambium layer is absent here. Fox K.M and Magaziner J et al; (3) are quick to point out to the fact that these fractures require to be intervened surgically and the modality adopted are dictated by the patient's age, the characteristic geometry of the fracture and the time elapsed between the injury perse and the surgical intervention.

In our study, the age group was 26-55 years with a mean of 47 years. Guyton J.L et al; (1) asserts that relatively high energy trauma is the cause and the treatment outcomes are related to anatomic reduction and fixation as quickly as possible, to reduce the chances of non-union and AVN. 50% (n=9) of our pateints were surgically intervened upon within 2 days of surgery and the remaining 50% (n=9) between the 3rd and 6th day of injury. We had 16.67% (n=3) of non-union and the very same patients went in also for AVN of the femoral head. The average age for Jain R et al; (7) was 45.9 years, for Damanay D.S et al; (8) it was 39.9 years and for Upadhyay A et al; (9) it was 37.7 years. For

Damanay D.S et al; (8) 2 out of 14 cases, for Upadhyay A et al; (9) 7 out of 50 cases and in our series 3 out of 18 cases went in for non-union and subsequent AVN of the femoral head.

Parker M.J et al; (10) states that good inter-observer reproducibility exists with Pauwell classification but is found to of limited use from the point of predicting the clinico-functional outcomes or the rates of complications in the various sub-types of the fracture. Blundell C.M et al; (11) states that the AO classification is very complicated and does not have significant prognostic importance. Garden's classification, according to Guyton J.L et al; (1) is the most widely used system of classification.

Bhandari M et al; (12) states that 92% of the surgeons preferred multiple cannulated screws for undisplaced and 68% of the surgeons prefer multiple cannulated screws fixation for displaced fractures of the femoral neck. Johansson A et al; (13) Lindequist S et al; (14) Swiontkowski M.F et al; (15) Linke B et al; (16) and Madsen F et al; (17) have highlighted the scientific rationale about using the multiple screws. Apart from them being less invasive, they tend to preserve more quantum of the cancellous bone and they further enhance the stability rotationally as well.

Huang HK et al; (18) who compared the various screw configuration way back in 2010, concluded in favor of the inverted triangle configuration with parallelly placed screws, with respect to the least rates of complications.

FQPP type of screw fixation, allows for controlled cancellous bone collapse, offers rotational stability, decreases hardware problems and offers a larger geometric voluminar area of fracture zone coverage in comparison to the three screws triangular construct. [Fig. 6].

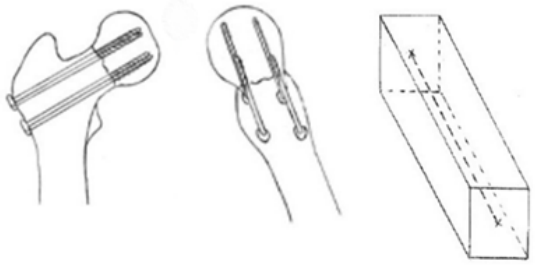


Fig. 6: FQPP Fixation Principle

In the BDSF technique of screw placement, there is a biplanar positioning of three screws. Thus, the BDSF construct has 2 calcar buttressed implants. In the lateral view, the distal screw touches on the posterior femoral neck cortex, offering substantially superior stability. The medial supporting point for the screws are at the solid calcar cortex, which works under pressure. The middle and distal screws rely on the solid cortex of the proximal femoral diaphysis and as thus their entry point acts as the lateral support. Thus, in brief, the BDSF provides for an antero - posterior neck stability. The bone weight borne by the screw placement is reduced. Stress fractures at the subtrochanteric level are significantly decreased. The screw placement also acts in tandem with the direction of the loading force, upon weight bearing.

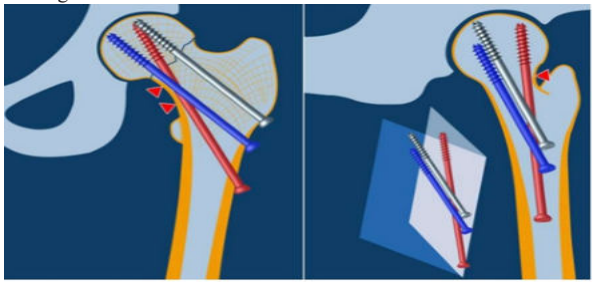


Fig. 7: BDSF Fixation Principle, Orlin Filipov's Method (19)

Our mean union time period was 16.2 weeks (range 14.2 to 24.4 weeks). Toe Touch mobilization with walker was initiated from 6th week onwards and Partial weight bearing walker mobilization was permitted from 8th week onwards. Full weight bearing mobilization was permitted only from 12th week of surgical intervention.

In our series, by the FQPP method at the 12th month follow-up the HHS evaluation was good to excellent in 55.56% (n=5) patients, fair in 22.22% (n=2) patients and poor in 22.22% (n=2) patients. On the other hand, by the BDSF method, it was good to excellent in 66.67% (n=6) patients, fair in 22.22% (n=2) patients and poor in 11.11% (n=1) patient. Thus, both the FQPP method and the BDSF method in this prospective short-term study gave almost comparable clinico-functional outcomes.

CONCLUSION:

Cancellous screw fixation is an appropriate surgical intervention for the middle aged (26-55 years) patients suffering a fracture neck of femur. Whether it be, by the FQPP method or the BDSF technique, be better left to the choice of the operating surgeon, as the present study failed to establish the clinico-functional outcome superiority of one methodology over the other.

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