



ORIGINAL RESEARCH PAPER

FUNCTIONAL OUTCOME OF NECK OF FEMUR FRACTURES IN ELDERLY TREATED WITH MODULAR UNCEMENTED BIPOLAR HEMIARTHROPLASTY- A DESCRIPTIVE LONGITUDINAL STUDY.

Orthopaedics

KEY WORDS: neck of femur, Uncemented, modular bipolar hemiarthroplasty.

Nagarjun. N*	Junior Resident In Orthopaedics, Mandya Institute Of Medical Sciences, Mandya, Karnataka, India-571401 *Corresponding Author
Manjappa. C.N	Professor And H.O.D In Orthopaedics, Mandya Institute Of Medical Sciences, Mandya, Karnataka, India-571401
Prashanth. G	Assistant Professor In Orthopaedics, Mandya Institute Of Medical Sciences, Mandya, Karnataka, India-571401
Dushyantha. M.C.	Junior Resident In Orthopaedics, Mandya Institute Of Medical Sciences, Mandya, Karnataka, India-571401
Naveen. B.S	Junior Resident In Orthopaedics, Mandya Institute Of Medical Sciences, Mandya, Karnataka, India-571401

ABSTRACT

Background: Fracture neck of femur and its complications account for significant morbidity and mortality in elderly patients. Uncemented Modular bipolar hemiarthroplasty helps in early mobilization of the patient as well as prolonging their productive life. **Objectives:** To describe the functional outcomes using clinical parameters in Elderly patients treated with uncemented modular bipolar hemiarthroplasty for femur neck fractures. **Materials And Methods:** 30 patients with fracture neck of femur and who were aged more than 60 years were included in this study. All patients are treated with uncemented Modular bipolar hemiarthroplasty. Functional outcome of these Patients are assessed using Harris Hip Score (HHS). Patients are also evaluated radiologically. The data is analysed with SPSS using chi-square test. **Results:** Our overall mean Harris hip score is 87.87(±10.23) and overall median is 91(84.5- 94.25). We have 18 (60%) excellent, 8 (27%) good, 2(7%) fair and 2(7%) poor results using Harris Hip Score(HHS) with uncemented Modular bipolar hemiarthroplasty. **Conclusion:** Hemiarthroplasty using Modular Uncemented Bipolar prosthesis for fractures of the displaced femoral neck in elderly provides better pain relief, better range of movement and more rapid return to unassisted activity with an acceptable complication rate. Though conventionally done in a cemented fashion, cementing is associated with higher cardiovascular complications in elderly uncemented modular hemiarthroplasty provides a good primary anchorage with equally promising results. Central/valgus stem position aids in better range of movements postoperatively with no/ minimal Limb length discrepancy respectively.

INTRODUCTION:

Hip fractures including the intracapsular neck fractures of proximal femur, in elderly women are common and may be increasing in elderly men. The estimated incidence of hip fractures was highest in western countries, lowest in China, India and intermediate in other regions. Hip fracture sufferers were estimated to 4.48 million worldwide with female to male ratio of 2.7. A total of 2.9 million disability adjusted life years were attributed to hip fractures.¹

Patients with displaced fractures who were operated with internal fixation had higher risk of reoperation, reported more pain, were less satisfied, and had lower quality of life than patients with undisplaced fractures treated with internal fixation. Patients with displaced fractures who were operated with hemiarthroplasty had a lower risk of reoperation than patients with undisplaced fractures who were treated with internal fixation. Furthermore, they had lower degree of pain, were more satisfied and reported higher quality of life.²

Between cemented and uncemented hemi replacement arthroplasty, the relative risk of postoperative outcomes of mortality and complications and pain were similar between them. Mortality rates at intermediate and long term follow up also were similar, as was perioperative mortality, the revision rate was lower for cemented cohort.³

Replacement of femoral head in displaced subcapital hip fractures has traditionally been accomplished with hemiarthroplasty using either unipolar, bipolar or modular component. A cemented stem has been considered the standard treatment in elderly people with osteoporotic bone. The cement is used to create instant stability to femoral stem to permit early weight bearing. But the mortality associated with cement in perioperative period was doubled(3.5% v/s

1.5%) mainly in patients with Cardiovascular disease including Angina or Ischemia, Congestive cardiac failure or peripheral vascular disease.⁴

The modular head with well fitted femoral component appears to be the ideal implant for most patients with displaced subcapital neck fractures that are community ambulators.⁴

Modular bipolar Hemiarthroplasty is associated with a low magnitude of surgery, low blood loss, relatively rapid or times, full weight bearing with a walker, an extremely low dislocation rate(2%), a good 8 year results as reported by Mayo Clinic, and good 10 year results as reported by Haidukewych et al.⁴

MATERIALS AND METHODS:

Study Design: Descriptive longitudinal study

Study Period: 1 year (September 2020 to August 2021)

Study Population: Cases of intracapsular fracture neck of femur undergoing Uncemented Modular bipolar hemiarthroplasty at department of Orthopaedics, Mandya Institute of Medical Sciences, Mandya.

Sample Size : 30

Sample size is calculated based on retrospective observation of last 6 months data in department of orthopaedics an average of 4 cases of neck of femur fractures in a month were operated for Uncemented modular bipolar hemiarthroplasty. So over a period of 6 months we will get around 30 cases in an average.

Sampling Method: Purposive Sampling.

Inclusion Criteria:

- 1) Patient who have given written informed consent for the study.
- 2) Patient aged more or equal to 60 years
- 3) Intra capsular neck of femur fractures
- 4) Closed fracture.

Exclusion Criteria:

- 1) Pathological fractures.
- 2) Fractures with compartment syndrome or impaired circulation.
- 3) Compound fracture.
- 4) If associated with other fractures
- 5) Previous surgeries in the affected limb

Method Of Data Collection:

Consent for the study is taken from patients who underwent Uncemented Modular Bipolar Hemiarthroplasty (Annexure 1), patients are assessed from 2nd postoperative week (visit 1), 6 weeks (visit 2) and 12 weeks (visit 3) and after 6 months (visit 4) from the date of surgery. At each visit the presenting complaints, general physical examination, local examination of the affected hip (Annexure 2) and standard radiographs of hip joint will be taken and functional score will be obtained using **Harris hip score** (annexure 4).

Plan For Data Analysis:

The collected data will be entered using Microsoft Excel software and analyzed using SPSS trial version. Descriptive statistics like mean, Standard Deviation, Proportions etc. Inferential statistics like t- test to know the difference between means, chi-square test to know the association, and other relevant statistical tests will be used.

RESULTS:

1. Age: The mean age of patients of our study is 68.33 (+/- 5.79) years.

Table 1:- Distribution Of Subjects According To AGE Group

Age	Frequency	Percent
60yrs	4	13.3
61-65yrs	9	30.0
66-70yrs	9	30.0
71-75yrs	4	13.3
>75yrs	4	13.3
Total	30	100.0

2. Sex: Sex Ratio Of Present Study Is 2:1.

Table 2: distribution Of Subjects According To Sex Group

Sex	Frequency	Percent
Female	20	66.7
Male	10	33.3
Total	30	100.0

3. Mode Of Injury: self fall after a trivial fall was the most common mode of injury

Table 3: Distribution of subjects according to MOI group

Mode of injury	Self fall after trivial fall	Work place injury	RTA
Percentage (%)	24(80%)	4(13%)	2(7%)

4. Type Of Fracture: Type 3 and 4 of gardens classification are the most common types.

Table 4: Distribution Of Subjects According To Type Of Fracture Group

Gardens classification	Type 3	Type 4
Percentage(%)	66.6%	33.3%

5. Pain: Distribution of subjects according to pain

Table 5: Distribution Of Subjects According To Pain Group

	Frequency	Percent(%)
Severe pain	0	0
Moderate pain	1	3.3
Slight, occasional Pain no compromise in activities	12	40.0
None or ignores it	17	56.7
Total	30	100.0

6. Function: It includes limp, support, walking distance and Activities.

a. Limp:

Table 6: Distribution Of Subjects According To LIMP

	Frequency	Percent
Severe	1	3.3
Moderate	1	3.3
Slight	10	33.3
None	18	60.0
Total	30	100.0

b. Support:

Table 7: Distribution Of Subjects According To Need For Support

	Frequency	Percent
Two crutches or not able to walk	1	3.3
Cane for long walks	10	33.3
None	19	63.3
Total	30	100.0

c. Walking Distance:

Table 8: Distribution Of Subjects According To Distance Walked

	Frequency	Percent
Bed and chair only	1	3.33%
Six blocks	8	26.66%
Unlimited	21	70%
Total	30	100.0

d. Activities: Includes climbing stairs, bending, sitting and entering a public transport.

Table 9: Distribution Of Subjects According To Climbing Stairs:

	Frequency	Percent
Unable to do stairs	1	3.3
In any manner	2	6.7
Normally using a railing	9	30.0
Normally without using a railing	18	60.0
Total	30	100.0

Table 10: Distribution Of Subjects According To Sitting

	Frequency	Percent
On a high chair for 30 minutes	11	36.7
Comfortably in an ordinary chair for one hour	19	63.3
Total	30	100.0

Table 11: Distribution Of Subjects According To Enter Public Transportation

	Frequency	Percent
No	2	6.7
Yes	28	93.3
Total	30	100.0

7. Range Of Motion:

Our study had 11 patients (36.7%) with excellent range of movements i.e., sum of > 210 degrees.

	Frequency	Percentage(%)
101-160°	6	20.0
161-210°	13	43.3
211- 300°	11	36.7

8. Functional Outcome: 26 (87%) patients are with good to excellent functional result using Harris Hip Score (HHS)

Table 13: Distribution Of Subjects According To Outcome

	Frequency	Percentage(%)
Excellent	18	60.0
Good	8	26.7
Fair	2	6.7
Poor	2	6.7
Total	30	100.0

9. Complications:

Table 14: Distribution of subjects according to complication group

Complication	Infection	Limb length discrepancy	Implant loosening	Dislocation
Percentage	3(10%)	(6.66%)	1(3.33%)	1(3.33%)

Comparison of mean age according to outcome

Table 15:

	Mean age in years	SD
Excellent	68.50	6.600
Good	70.13	6.357
Fair	62.50	3.536
Poor	65.50	.707
Total	68.33	6.288

P value 0.444, there was no statistically significant difference found between age and outcome

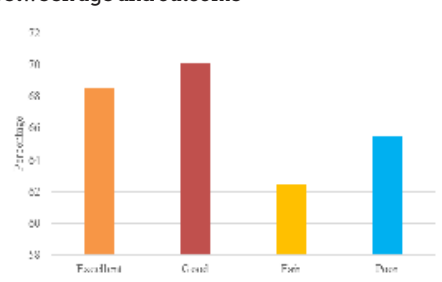


Figure 1:- Graph showing Comparison of mean age according to outcome.

DISCUSSION:

1. Mean Age Of Patients:

Leighton et al.³⁶ recommend prosthetic replacement for patients more than 60 years old and having a displaced femoral neck fracture.

Mean age of patients in our study was 68.33 years which is comparable to studies of sharanprakash et al³¹ and Zahid Bashir et al¹⁰

Table 16

	Ankush V M et al	Sharanprakash et al ³²	Zahid basher et al ¹⁰	Present study
Meanage (years)	70.03	70.2	72.4	68.33

Uncemented modular hemiarthroplasty can be an implant of choice in mobile active patients as it offers better survival of prosthesis for about 15 to 20 years.

2. Sex: In total of 30 patients, 20 are females and 10 are males. Which are comparable to other studies.

Table 17

	Ankush V M et al	Sharanprakash et al ³²	Zahid basher et al ¹⁰	present study
SEX RATIO	22F 18M 1.22:1	21F 12M 1.75:1	30F 30M 1:1	20F 10M 2:1

Females are more commonly affected may be due to osteoporosis and due to longevity of life.

3. Mode Of Injury:

Self fall/ trivial fall near backyards of their home over the hip was the most common mode of injury (28cases) and others are cases of road traffic accident (RTA)(2cases). The data is comparable with other studies.

Table 18

	Ankush V M et al	Sharanprakash et al	Zahid basher et al	Present study
Trivial fall/self fall	97.5%	90.5%	90%	93.33%

Since the common age group are old aged, who are more of field workers/ home makers who develop a fall near their farm/ home than to have a road traffic accident.

4. Type Of Fracture: Type 3 and 4 of Gardens classification were common types presented.

Table 19:

	Ankush VM et al	Sharanprakash et al ³¹	Zahid basher et al	Present study
Type 3	65%	66.7%	40%	66.6%(20 cases)
Type 4	35%	18.3%	60%	33.3%(10 cases)

Type 3 and 4 fractures are common since even a low grade fractures can be displaced subsequently with weight bearing or due to lower healing capacity.

5. Pain: 17 patients (56.7%) had no pain, 12(40%) patients had slight or intermittent pain and 1 patient had moderate pain. None of the patients had marked or severe pain. None of the patients was totally disabled in terms of pain. The average pain score was 41.93 +/- 2.99. The results are comparable to other studies.

Table 20:

Author	Patients with NO / SLIGHT PAIN(%)
Zahid Bashir et al ¹⁰	83.33
Marya SKS et al	94
Sharanprakash et al	80
Present study	97

The decrease in pain may be due to selection of right sized stem and prosthetic head.

Adequate analgesia, ante edema measures and maintaining of stable limb position also contributes for pain reduction.

6. Function:

Table 21:

Author	Mean functional score
Zahid Bashir et al ¹⁰	34.63 (25 - 43)
Sharan prakash et al	40.1(37-43)
Marya SKS et al	39.5(37- 43)
Present study	40.76 (37.4- 45)

In our study, postoperatively none of our patients had limp. All our cases were done through posterior approach. Hardinge³⁵ believed that limp occurred less frequently when a posterior approach is used. (Jbjs 64 b 17-191982). Our present study has 85% (25 cases) of central femur stem position which offers no limb length discrepancy (LLD) that decreases limp.

Early mobilization, early assisted and active muscle strengthening exercises minimizes soft tissue contracture and muscle wasting which improves functional capacity.

7. Range Of Motion:

In Our study 11 patients(36.7%)with excellent range of movements.i.e.,sum of > 210degrees which is comparable to other studies.

Table 22:

AUTHOR	ROM(EXCELLANT %)
Zahir basher et al	25%
Sharan prakash et al	15%
Marya SKS et al	30%
Our study	36.7%

Early weight baring, early assisted and active muscle strengthening exercises and application of adequate fit implant leads to better function and Range of movements (ROM).

8. Functional Outcome:.
 Wehave 18 (60%) excellent, 8 (27%) good, 2(7%) fair and 2(7%) poor results using harris hip score(HHS), which are comparable to other studies.

87% of good to excellent outcome is seen in present study.

Table 23:

	Sharanprakash et al	Marya SKS et al	Zahid Bashir et al ¹⁰	Present study
Excellent	20%	6%	43.5%	60%
Good	70%	71%	38.4%	26.66%
Fair	10%	20%	11.3%	6.66%
Poor	0	3%	6.8%	6.66%

Early weight baring, early assisted and active muscle strengthening exercises and application of adequate fit implant leads to better function and Range of movements (ROM).

9. Complications:
1. Limblengthdiscrepancy:
 We had 2 cases of lengthening of about 1cm and 1.2 cm respectively. Equalization of leg length with a Modular bipolar hemiarthroplasty is adequate due to proper neck length selection and adequate broaching of femoral canal with appropriate sized stem. The ideal femoral stem position is central. In our study, we had 25 stem in neutral position, 4 stem in valgus and 1 stem in varus position.

Table 24:

Stem position	Barnes et al ²²	Zahid Bhashir ¹⁰	Present study
Central	85%	84.4%	83.3%
Varus	4%	5.7%	3.33%
Valgus	11%	9.9%	13.33%

Foot wear correction was given to the above patients. Discrepancies of 1 cm generally are well tolerated, and perception of thediscrepancy tends to diminish with time. Apparent leg length inequality andpelvic obliquity caused by residual soft tissue contracture usually responds tophysical therapy with stretching and improve with time.¹⁵

2. Implant Loosening And Dislocation:
 Inourstudy,wehadone case of Dislocation with uncemented modular bipolar prosthesis which was treated with implant removal and subsequent cemented bipolar hemiarthroplasty.

Wehave1(3.33%) dislocation rate, which is relatively low, and is because we fasten abduction pillow to the leg postoperatively, for 1 to 2 weeks, along the careful shifting of the patients from theatre table tothe bed and also for X-ray.

Table 25:

	Barneset al ²²	Zahid Bashir ¹⁰	Our Study
Dislocation rate(%)	1.5	0	1

3. Infection:
 We had one case of deep infection extending to the implant. It was treated with implant removal and insertion of modular

bipolar simulant and was subsequent resurgery with total hip replacement once the infection is subsided i.e., after 6 weeks of implant removal. 2 cases of superficial skin infection noted, they were treated with daily dressing and administration of antibiotics according to culture reports.

Table 26:

	Zahid Bashir ¹⁰ al ²²	Barnes et	Present study
Percentage of infection	4%	10%	10%

Decrease in rate of infection may be due to administration of prophylactic antibiotic just before incision, preliminary scrub is given, painting and draping is done maintaining utmost sterility. Antibiotic is continued for 3 days postoperatively. Sterile dressing is done. Lesser surgical time and surgeries are done by experienced personnel.

CONCLUSION
 Hemiarthroplasty using Modular Uncemented Bipolar prosthesis for fractures of the displaced femoral neck in elderly provides pain relief, better range of movements and more rapid return to unassisted activity with an acceptable complication rate.Though conventionally done in a cemented fashion, uncemented modular hemiarthroplasty provides a good primary anchorage with equally promising results and are better suited for patients with high cardiovascular risk factors for whom cementing is contraindicated. Uncemented is associated with lower operating time, newer uncemented stem are coated with ceramic or hydroxyapatite which helps in stable implantation. The stem also have beaded and porous surface which help in bone growth in future and stable implantation. The average viability of the implant is about 15 to 20 years which aids mobile active patients. The end functional results also depend on the associated co-morbidity and optimum postoperative rehabilitation. Throughout the purview of the present study, our experience with Uncemented Modular bipolar prosthesis has been better.The short term outcome from this study provides evidence that this is suitable treatment option in displaced intracapsular fracture neck of femur in elderly.

Financial Support And Sponsorship
 Nil.

Conflicts Of Interest
 There are no conflicts of interest

Clinical Images:
Case 1



Flexion



Internal Rotation



Adduction



External Rotation



Abduction

Case 2



Flexion



Abduction



Adduction



External Rotation



Internal Rotation



Preop Xray



Postop Xray



Preop Xray



Post Op Xray

Case 3
 Case Of Deep Infection : Noted After 15 Days Of Surgery



Wound Picture



Preoperative X-Ray Image OfThe Patient



Postoperative X Ray Image OfThe Patient



Intra Operative Image OfDebridement



Postoperative Image After Wound Debridement And Implant Removal

REFERENCES

- 1) Ahn J, Man XL, Park S, Sodl JF, Esterhai JL. Systematic review of cemented and uncemented hemiarthroplasty outcomes for femoral neck fractures. Clin Orthop Relat Res 2008; 466:2513-2518.
- 2) Barnes CL, Berry DJ, Sledge CB. Dislocation after bipolar hemiarthroplasty of the hip. J Arthroplasty 1995; 10:667-9.
- 3) Campbell's operative orthopaedics: ed: Terry Canale and James H. Beaty; 12th ed. Elsevier, St. Louis, Mo. 2013. Pp:181
- 4) Canale ST. Hip fractures and dislocations. Campbell's Operative Orthopaedics, 11th ed. Mosby; 2012.
- 5) Carl Johan Headbeck et al unipolar hemiarthroplasty versus bipolar hemiarthroplasty in the most elderly patients with displaced neck of femur fractures International Orthopedics (SICOT) (2011) 35:1703-1711
- 6) Chapman MW, Chapman's orthopaedic surgery. 4th edition Jaypee Brothers Medical Publishers; 4th Revised edition.
- 7) Dhar D. Early Results of Austin Moore Prosthesis in Elderly Patients with fracture neck femur. J Orthop 2007; 4(1):e3.
- 8) Functional outcome of cemented v/s uncemented modular bipolar hemiarthroplasty in proximal femur neck fractures by Ankush V Mohabey et al G. Solarino et al Hip hemiarthroplasty with Modular neck : Is it useful in Residents learning Curve? A Prospective Clinical Study.
- 9) Gjertsen JE, Fevang JM, Matre K, Vinje T, Engesaeter LB. Clinical outcome after undisplaced femoral neck fractures. Acta Orthop 2011; 82:268-274.
- 10) Haidukewych GJ, Israel A and Berry DJ. Long-term survivorship of uncemented bipolar hemiarthroplasty for fracture of the femoral neck. Clin Orthop Relat Res 2012; 403:118-126.
- 11) Hamblen D. L. Ectopic ossification in complications of Total Hip Replacement. Ed: R. S. M. Ling London, Churchill Livingstone; 1984.
- 12) Hanu Tej Adapureddi, Kamareddy SB, Anand Kumar, Sri Krishna Paturi, Sandeep Anne, Jaya Prakash Reddy. Prospective Study of Management of Femur Neck Fracture by Hemiarthroplasty with Uncemented Bipolar. Journal of Evolution of Medical and Dental Sciences. 2015; 4(98):16309-16314.
- 13) Hardinge K. Direct lateral approach to hip. JBJS 64B:17-19, 1982
- 14) Iorio R, Schwartz B, Macaulay W, Teeney SM, Healy WL, York S. Surgical treatment of displaced femoral neck fractures in the elderly: a survey of the American Association of Hip and Knee Surgeons. J Arthroplasty 2006; 21:1124-33.
- 15) Jadhav AP, Kulkarni SS, Vaidya SV, Divekar MM, Suralkar SP. Results of Austin Moore replacement. J Postgrad Med 1996; 42:33-8
- 16) Johnell O, Kanis JA. An estimate of the worldwide prevalence, mortality and disability associated with hip fracture. Osteoporos Int 2004; 15:897-902.
- 17) Leighton RK, Schmidt AH, Collier P, Trask K. Advances in the treatment of intracapsular hip fractures in the elderly. 2007; 38(Suppl 3):S24-34.
- 18) Leighton RK, Schmidt AH, Collier P, Trask K. Advances in the treatment of intracapsular hip fractures in the elderly. Injury 2007; 38:S24-34.
- 19) Maini PS, Talwar N, Nijhawan VK, Dhawan M. Results of uncemented bipolar hemiarthroplasty for fracture of the femoral neck - 10 year study. Indian Journal of Orthopaedics. 2006; 40(3):154-156.
- 20) Maloney WJ, Krushell RJ, Jasty M, Harris WH. Incidence of heterotopic ossification after total hip replacement: effect of the type of fixation of the femoral component. J Bone Joint Surg Am 1991; 73(2):191-3.
- 21) Marya SKS, Thukral R, Singh C. Prosthetic replacement in femoral neck fracture in the elderly: Results and review of the literature. Indian J Orthop 2008; 42(1):61-7.
- 22) Moshin, Bhandari M, Devereaux PJ, Tometta P 3rd, et al. Operative management of displaced femoral neck fractures in elderly patients. An international survey. J Bone Joint Surg Am 2005; 87:2122-30.
- 23) Noor SS, Hussain N, Javed I. Outcome of Austin Moore hemiarthroplasty in elderly patients with fracture neck of femur. J Pak Orthop Assoc 2010; 22(1):14-19.
- 24) Prospective study in surgical management of femur neck fractures with hemiarthroplasty using uncemented modular bipolar prosthesis by Sharan Prasad AH, OB Pattanashetty et al.
- 25) Prospective study in surgical management of fracture neck of femur with hemiarthroplasty using modular bipolar prosthesis Pradeep Kumar Natikar, Abrar Mohammed et al
- 26) Ritter MA, Gioe TJ. The effect of indomethacin on para articular ectopic ossification following total hip arthroplasty. Clin Orthop Relat Res 1982; (167):113-7
- 27) Rockwood and Wilkins' Fractures in Children. Ed: Beaty JH. Kasser JR. 7th ed. Philadelphia: Lippincott, Williams & Wilkins. pp.1057
- 28) Rosendahl, S, Christofferson J.K and Norgaard M; para articular ossification following hip replacement. 70 arthroplasties admodum Moore using a farland approach. Acta orthop. Scandinavica, 48:400-404, 1977.
- 29) S.K. Rai et al Cemented versus Uncemented modular bipolar hemiarthroplasty treatment for the femoral neck fractures in elderly patients Journal of Arthroscopy and Joint surgery 4(2017)127-130
- 30) Shekhar A, Murgod G, Korihalli S. Two years outcome of cemented Austin Moore hemiarthroplasty for fracture neck femur. J Dent Med Sci 2013; 11(6):10-15.
- 31) Somashekar, MS, Sathya Vamshi Krishna, MS, Sridhara Murthy JN, MS Treatment of femoral neck fractures : Unipolar Versus Bipolar Hemiarthroplasty, Malaysian Orthopedic Journal 2013 vol 7 No 3
- 32) Victor CR. Unipolar versus bipolar Arthroplasty. Tech orthop 2004; 19(3):138-42.
- 33) Yamagata M, Chao EY, Ilstrop DM, Melton LJ 3rd, Coventry MB, Stauffer RN. "Fixed-head and bipolar hip endoprosthesis. A retrospective clinical and roentgenographic study" Clinical orthopaedics and related research J. Arthroplasty. 1987; 2(4):327-41
- 34) Yik-Fung Mak et al modular bipolar hemiarthroplasty for the fracture neck of femur using contemporary cementing technique : Long term results of a single design, Journal of orthopedics, Trauma and Rehabilitation 2018, Vol, 26(1) 67-73
- 35) Zahid Bashir et al, functional outcome of uncemented modular bipolar hemiarthroplasty using modified Harris Hip Score (HHS) for fractures of femoral neck in elderly.