

Research Article

Evaluation of osteoporotic trochanteric fractures treated with cement-augmented dynamic hip screw

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ABSTRACT

Background: Dynamic hip screw (DHS) has been the standard treatment for stable trochanteric fracture patterns. However, primary stabilization with dynamic/sliding hip screw is not always successful, especially in osteoporotic fractures. Internal fixation in such a situation may achieve a satisfactory initial fracture site reduction, but late fracture collapse into varus during weight bearing, can lead to a high failure rate. Since 1975, polymethylmethacrylate (PMMA) cement-augmented DHS have been used as a solution in unstable ITFs by adding an anchoring ability to the lag screw.

Methods: A series of 33 osteoporotic intertrochanteric fractures were operated with cement augmented dynamic hip screw. One patient lost to follow up. All patients were then allowed partial weight bearing walker aided ambulation under the guidance of physiotherapist on the second or third postoperative day. The patients were followed radio logically and clinically at regular intervals (1st month, than at 3rd month and then at 6th month interval after surgery). Results were graded as excellent (score >31), good (score 24-31), fair (score 16-23), and poor (score <16). Clinical result was given according to Salvati and Wilson scoring.

Results: Total 33 patients were taken for the study they were followed for minimum 6 months and at 6 months the clinical outcome was rated as per the Salvati and Wilson scoring system. One patient lost to follow-up. Final clinical results as evaluated by Salvati and Wilson scoring were; excellent in 24 cases (75%), good in 7 cases (21.88%), fair in 1 case (3.12%) and poor in 0 cases (0%). There were no non-union, AVN, implant failure and screw cut-out in our study.

Conclusions: The surgical management of intertrochanteric fractures with PMMA augmented DHS provide a stable fixation with moderate pain free early mobilisation and better outcome in osteoporotic patients without the complications of superior screw cut-out, sliding collapse, and with the appropriate placement of bone cement along with proper amount (4-5 ml) of cement we can also reduce the cement related complications such as delayed healing, nonunion, heat necrosis and avascular necrosis.

Keywords: Dynamic hip screw, Osteoporosis, Screw cut out, Polymethylmethacrylate, Salvati and Wilson score

INTRODUCTION

Intertrochanteric fracture is one of the most common fractures of the hip especially in elderly with osteoporotic bones usually due to low energy trauma like simple falls. These fractures have bimodal age distribution with 90% occurring after 50 years of age by minimal to moderate

physical trauma in areas of bone significantly affected by osteoporosis. This incidence doubles every 10 years after 50 years of age.^{1,2}

This increased incidence with increasing age can be attributed to osteoporosis and bone loss which in turn is due to decreased physical activity.³⁻⁶ As life expectancy is

increasing so is the number of intertrochanteric fractures. Osteoporotic females outnumber males in incidence (2-3:1).^{1,7}

Before the introduction of suitable fixation devices, treatment of intertrochanteric fractures was non-operative, consisting of prolonged bed rest in traction until fracture healing occurred (usually 10–12 weeks), followed by a lengthy programme of ambulation training. In elderly patients, this approach was associated with high complication rates; typical problems included decubitus ulcers, urinary tract infection, joint contractures, pneumonia and thromboembolic complications, resulting in a high mortality rate. In addition, fracture healing was generally accompanied by varus deformity and shortening because of the inability of traction to effectively counteract the deforming muscular forces. That's why intertrochanteric fractures are almost always treated by early internal fixation to obtain the best possible position and to get early mobilization thereby reducing the risk of prolonged recumbency.

Various devices for the internal fixation of intertrochanteric fracture used nowadays are dynamic hip screw, intramedullary nailing with sliding hip screw and arthroplasty. The use of static implants with fixed angle at nail plate junction is no longer justified since DHS has given uniformly good results due to controlled impaction and stable contact of the fragments. The sliding hip screw has gained universal popularity as the fixation device for intertrochanteric fractures. DHS is gold standard. Majority of technical failures however consist of collapse of fracture area and cutting out of neck screw caused by rotation potential of head neck fragment and/or malpositioning of neck screw. Despite the wide spread use of these implants failure rate as high as 8 - 17% is reported in some series.

Dynamic hip screw (DHS) has been the standard treatment for stable trochanteric fracture patterns. However, primary stabilization with dynamic/sliding hip screw is not always successful, especially in osteoporotic fractures. Low bone mineral density and thin cortices are not only major risk factors for hip fractures, but also contribute to the failure of fracture fixation in elderly patients on account of excessive collapse and lag screw cut-out from the superior aspect.⁸⁻¹⁰ Internal fixation in such a situation may achieve a satisfactory initial fracture site reduction, but late fracture collapse into varus during weight bearing, can lead to a high failure rate.¹¹ Mechanical stability after fixation in these fractures is dependent on the quality of bone, fracture personality, quality of reduction, and choice of implants.¹² In the past, various methods such as valgus osteotomy, valgus reduction with tension-band wiring, lateral wall reconstruction, and a variety of other techniques have been developed, in an attempt to reduce the rate of complications in the management of these fractures.¹³⁻¹⁶ However, none of these have been able to completely address the problem of implant failure in osteoporotic

patients, due to a superior screw cut out.^{15,16} Since 1975, polymethylmethacrylate (PMMA) cement-augmented DHS have been used as a solution in unstable ITFs by adding an anchoring ability to the lag screw.¹⁶ Some encouraging results have been observed, showing a higher success rate and better functional recovery than with conventional DHS.^{17,18} But the technique has not gained wide acceptance due to associated complications like delayed union and nonunion.¹⁶⁻¹⁹

The objective of augmentation with bone cement is to provide immediate strength to aid lag screw anchorage and early weight bearing.

This prospective study was conducted to evaluate the outcome and efficacy of PMMA augmented DHS in elderly osteoporotic patients with intertrochanteric fractures.

METHODS

The study was conducted prospectively on the patients with intertrochanteric fractures who got admitted during April 2014 to June 2015 with follow up of minimum 6 months.

Patients with closed intertrochanteric fracture, age more than 60 years, DEXA T Score ≤ -2.5 were included in the study after taking written consent form from them.

Exclusion criteria were open fracture, subtrochanteric fracture, pathological fracture, intracapsular fracture neck of femur, patient with multiple injuries, patients who were non ambulatory prior to their injury, patient with dementia severe enough to limit their ability to comply with postoperative rehabilitation.

A total of 33 patients went through the procedure who got admitted and met the criteria. 1 patient lost to follow up.

Subject enrolment

Patients who have fulfilled the inclusion and exclusion criteria, all the study subjects were chosen from casualty and orthopaedic OPD with intertrochanteric fractures. All patients were informed about all the possible modalities of treatment and the superiority of dynamic hip screw fixation over others and about the benefits of cement augmentation in an osteoporotic bone over non augmentation, only the patients who had given their consent were operated by cement augmentation and included in study.

Preoperative evaluation

Detailed history was taken about the traumatic event, comorbid conditions and any on-going medication specially any anticoagulant. Detailed Physical examination was performed in every case and documentation was done. Patients were put on analgesic support, preoperatively.

Dual energy X-ray absorptiometry (DEXA) scan of the contra lateral hip of the patients were done and only those patients with established osteoporosis (T score <-2.5) were included in the study. All fractures were classified on the basis of AO classification.

All routine investigations were sent including – complete blood count, blood grouping, fasting and random blood sugar, liver function and Renal Function tests, ECG, urine routine and microscopy, x-ray chest AP view and viral markers.

Pre-anaesthetic check-up was done on a day prior to surgery with clearance from concerned speciality in case of co-morbid conditions. Patient as well as family members were explained about the surgery and the risk factors, and the consent for the same was taken.

Operative procedure

All surgeries were performed on the radiolucent table with patient in the supine position. Prophylactic antibiotic was administered half an hour prior to surgery, part preparation done after appropriate anaesthesia. All surgeries were performed using Lateral approach, reduction achieved under image intensifier. Guide wire was passed central to femoral neck, confirmed under C-arm in both AP and lateral view care was taken not to perforate the femoral head.

After depth measurement triple reaming and tapping was done. Another guide wire was placed above and parallel to first one and then first guide wire was removed and PMMA bone cement of around 10 to 15 ml was mixed and placed in a disposable injection type of syringe attached with cement gun as shown in Figure 1 and 2 in a semi liquid state. The long and narrow nozzle of the syringe was inserted into the hole femoral canal. As the piston was pressed, the barrel was pulled back slowly, so as to inject cement from the deepest part of the head outward, up to the base of the femoral head as in Figure 3.



Figure 1: Disposable syringe with long nozzle.



Figure 2: Cement gun.



Figure 3: C-arm image while depositing cement by the use of injection type syringe.

Finally the lag screw of appropriate size and then plate was applied, haemostasis achieved, wound closure was done in layers after placing drain.

Post operative period

Vitals monitoring done for first 24 hours, postoperative blood transfusion done (if haemoglobin was <8). Analgesics and other medication used as required. CBC, RFT on first postoperative day were done. DVT prophylaxis was started on first postoperative day and the protocol was same for all patients, bed side sitting on first postoperative day with active and passive exercises.

On second postoperative day we have done radiological assessment with Antero-posterior and lateral view of hip involved and the length from the tip of lag screw to the lateral barrel plate and tip apex distance (TAD) was also assessed. The degree of sliding was calculated by measuring the change in the length from tip of lag screw to the lateral barrel plate in follow up and compared with immediate postoperative calculated length. TAD is the sum of the distances from the tip of lag screw to the apex of femoral head on both AP and lateral radiographic views, it predicts the lag screw position within the femoral head and is believed to be an independent predictor of lag screw cut out. A TAD of less than 20 mm

result in a zero percent occurrence of screw cut out (as cut-out associate with screw positioning). Dressing with drain removal was done on second postoperative day. All patients were then allowed partial weight bearing walker aided ambulation under the guidance of physiotherapist on the second or third postoperative day. Patient discharged after full rehabilitation and with proper discharge advice. Suture removal done after 2 weeks.

Follow up

The patients were followed radio logically and clinically at regular intervals (1st month, than at 3rd month and then at 6th month interval after surgery). The clinical outcome was rated as per Salvati and Wilsons score. Final radiological evaluation will include non-union, screw cut out, the extent of sliding collapse and varus collapse.



Figure 4: Preoperative X-ray.

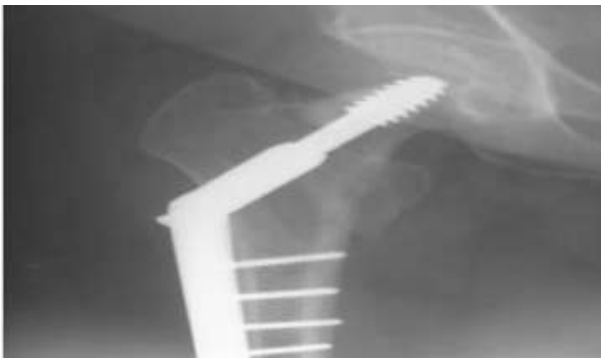


Figure 5: Postoperative X-ray.

All patients were allowed partial weight bearing ambulation under the guidance of a physiotherapist on the second or third postoperative days, and were allowed full weight bearing as soon as possible, depending on the tolerance of the patient. The patients were followed up clinically and radiologically at regular intervals, initially monthly, for the first six months and then every three months, for progress of union, for a minimum period of 6 months. Postoperative radiological assessment included

degree of sliding, varus collapse, fracture union, and tip apex distance (TAD) evaluation. The clinical outcome was rated as per the Salvati and Wilson scoring system at the minimum of six months. Results were graded as excellent (score >31), good (score 24–31), fair (score 16–23), and poor (score <16). Final radiological evaluation included any nonunion, malunion, screw cut-out and implant breakage, AVN of the femoral head, and the extent of sliding collapse.

RESULTS

A series of 33 osteoporotic intertrochanteric fractures were operated with cement augmented dynamic hip screw. The average age in this series was 78.93 years. Maximum age was 92 years. Minimum age was 65 years. Most of the patients were between 71-80 years of age (60.61%).

Out of 33 cases 13 were males (39.39%) and 20 were females (60.61%). Female:Male ratio was 1.54:1. The fractures were more on right side. Right to left ratio was 1.36:1. The most common cause of trauma was slip and fall (28 cases, 84.85%) followed by RTA (5 cases, 15.15%). Incidence of associated fractures was 8 cases (24.24%). These included fracture pubic ramus, fracture colles, fracture clavicle and fracture neck of humerus (NOH). Majority of fractures of type AO 31-A2 (16 cases, 48.48%) as given in Figure 6.

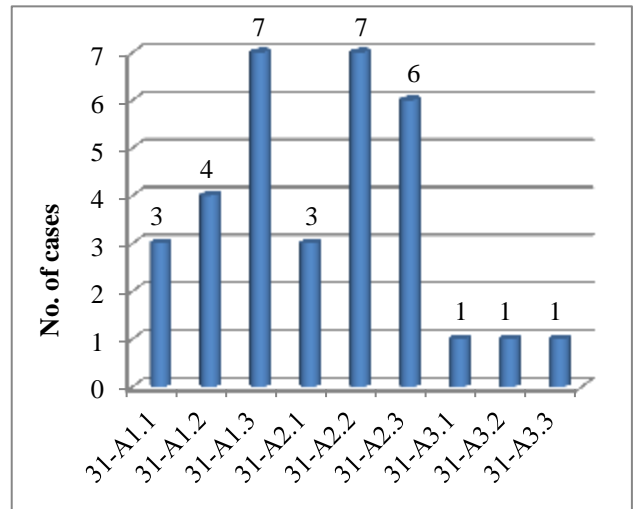


Figure 6: Fracture distribution a/c to AO classification.

15 cases (45.45%) had associated medical problems. The most common was hypertension (6 cases, 18.18%), followed by diabetes mellitus (5 cases, 15.15%) and chronic obstructive pulmonary disease (4 cases, 12.12%). Total 33 patients were taken for the study they were followed for minimum 6 months and at 6 months the clinical outcome was rated as per the Salvati and Wilson scoring system. One patient lost to follow-up. Results were graded as excellent (score >31), good (score 24-31),

fair (score 16–23), and poor (score <16). Clinical result was given according to Salvati and Wilson scoring as shown in Figure 7.

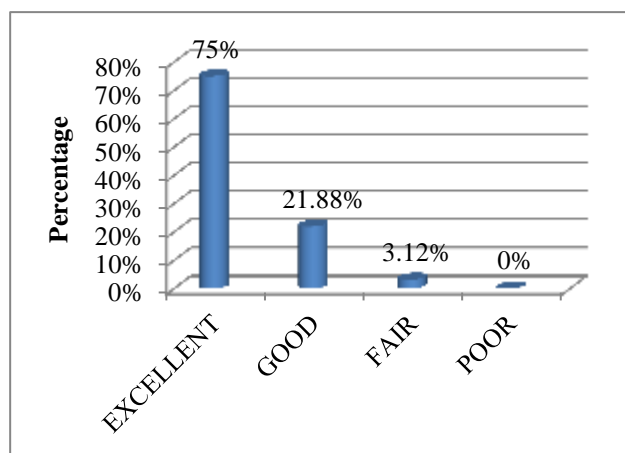


Figure 7: Clinical results.

DISCUSSION

The Intertrochanteric fractures are one of the most common fractures of the hip especially in the elderly with osteoporotic bones. It usually occurs due to low-energy trauma like simple fall. The incidence of hip fractures occurring worldwide has been expected to increase from 1.66 million in 1990 to 6.26 million in 2050 and this can be explained by increase in life expectancy.²⁰

Management of these osteoporotic fractures in elderly age group pose a serious problem. Surgical management of trochanteric fractures aims at restoring the pre-fracture functional status of patients as soon as possible, to avoid problems of prolonged recumbency. However, primary stabilization with standard dynamic hip screw is not always free from complications especially in osteoporotic fractures. In elderly patients qualitative deterioration of bone (osteoporosis) in spite of being a major risk factor for hip fractures, also contribute to the failure of fracture fixation in elderly patients on account of excessive collapse and lag screw cut-out from the superior aspect.^{9,10} Sliding hip screw successfully address the issue of femoral head penetration, which was the problem with earlier fixed devices.²¹ Despite the success of dynamic hip screw in treating intertrochanteric fractures, there were certain issues which need to be addressed, as per the previous studies those potential issues were not even addressed by intramedullary fixation devices. An obvious means to improve the fixation of a cancellous bone screws is to provide strong anchorage surrounding the threaded portion of lag screw. Implant augmentation with cement has been used in fracture fixation since the use of PMMA in 1962.²² Clinical as well as biomechanical studies have demonstrated that the adequate use of PMMA cement provides rapid weight-bearing stability to the fracture fixation.^{18,16}

We have conducted a prospective comparative study to evaluate the efficacy of PMMA augmented DHS in elderly osteoporotic patients with intertrochanteric fractures.

The average age in this series was 78.93 years (65-92 years). Most of the patients were between 71-80 years of age (60.61%). Female predominated with a ratio of 1.54:1. Other studies also have shown that these fractures are more common in elderly age group with female predominance.²³

Most fractures were on right side (57.58%). Average T-score on DEXA scan was -2.87 (-2.5 to -3.2). There were 8 cases of associated fractures (fracture pubic rami, fracture colles, fracture neck of humerus, fracture clavicle). 15 cases had associated medical problems like hypertension, diabetes mellitus and chronic obstructive pulmonary disease.

In our study commonest mode of injury was slip and fall (84.85%) as compared to Gupta et al having fall as the mode of injury in 85% of cases.²³ Fall from same level at home being the most common aetiology for elderly female osteoporotic hip fractures, so there is an urgent need to develop preventive strategies, particularly in the developing countries like India.

To classify these fractures we have used AO classification system in our study, which is the most referenced classification in recent scientific articles and is a derivative of Muller classification.²⁴

In our study, the average DEXA-t score was 2.87 (-2.5 to -3.2), as compared to the average T score 2.8 (-2.5 to -3.4) in the study of Gupta et al.²⁵

Tip apex distance predicts the lag screw position within the femoral head and is believed to be an independent predictor of lag screw cut out. In our study average tip apex distance of 19.91 mm (11-29 mm) as compared to the average TAD of 20.8 mm in the study of Gupta et al with no screw cut-out, there were no screw cut-out in our study too.²³

In our study there was no sliding collapse in cemented DHS in accordance with the study of Gupta et al, by Lee et al and previous other studies.^{23,25} In our study there was no varus collapse accordance with the studies by Lee et al, Kim et al.^{25,26}

Cement-augmented DHS have a different failure mode than screw cut-out in conventional DHS. Failures tended to be more related to delayed union, non-union and resultant side plate construct failure as concluded by Wu MH et al.²⁷ In our study there were no cases of non-union, the average time to union was 14.12 (12-17) weeks, and there was no case of side plate construct failure.

Amount of cement and its placement also have an impact on the cement related complications such as heat necrosis

and ineffectiveness of dynamic hip screw mechanism. Cheng et al concluded that, complications in their series of intertrochanteric fractures were due to inappropriate placement and excessive amount of PMMA cement, Boner et al evaluated the risk of thermal necrosis when augmenting the implant purchase with PMMA.^{28,29} They concluded no risk of thermal necrosis at the PMMA/bone interface or in the surrounding bone upto 6.0 cc PMMA. In a study by Lee et al using cement augmentation with DHS, with an average amount 13.7 ml of PMMA.²⁵ It has been recognized that bone necrosis is dose dependent, so it is advisable to use a minimum amount of bone cement. In our study we have used 4-5 ml of PMMA and there were no cases of thermal necrosis and avascular necrosis.

One of the major concerns during cement injection is the penetration of the cement into the joint. It is therefore important that the guide wire reach only the sub-chondral bone and not penetrate into the joint and position of guide wire should be central in both radiological views. We have injected cement through injection type syringe after wire removal in contrast to the study of Gupta et al where guide wire was kept in situ during cement injection with their custom made gun.²³ There was no instance of cement penetration and difficulty in implant positioning in our study.

Cement augmentation added another step to the surgical procedure and prolonged our operating time by approximately six to seven minutes (the mean duration of operation was 68.00 min (58-74 min) in contrast to four to five minutes in the study of Gupta et al. But in our study the difference was not statistically significant. Intra-operative bleeding is in part related to the operating time, but if proper haemostasis is achieved, there is hardly any extra blood loss during surgery, on account of cement augmentation.

In our study augmentation with PMMA provided a modest reduction in pain, improvement in quality of life, early weight bearing and lower overall complication rate during course of healing. This was in accordance with the studies by Gupta et al, Lee et al, Dall'Oca et al and other previous studies.^{23,25,28}

Final clinical results as evaluated by Salvati and Wilson score were excellent in 24 cases (75%), good in 7 cases (21.88%) fair in 1 case (3.12%) and poor in 0 case (0%).

The strength of our study is that cases were operated by same surgeon and at a single centre, this shows that there was consistency in surgical technique and implant use in the study. This study introduces a new manner to introduce cement into the femoral head that is clinically relevant, with a negligible risk of cement penetration into hip joint and in an appropriate location.

Our study had limitation that the, number of patients were limited and follow up period was short. The information of this study can be used for patients and as a reference for further studies

CONCLUSION

On the basis of our prospective comparative study we conclude that the surgical management of intertrochanteric fractures with PMMA augmented DHS provide a stable fixation with moderate pain free early mobilisation and better outcome in osteoporotic patients without the complications of superior screw cut-out, sliding collapse, and with the appropriate placement of bone cement along with proper amount (4-5 ml) of cement we can also reduce the cement related complications such as delayed healing, non-union, heat necrosis, and avascular necrosis.

PMMA being inert and non-biodegradable is likely to persist within the femoral head forever. Long term persistence of PMMA may influence the rate of bone remodelling by affecting bone metabolism and the trabeculae may be weakened by change in the mechanical environment. Thus, it is advocated that PMMA augmentation should only be used in elderly patients with osteoporosis and limited life expectancy, till long term results are available.

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Conflict of interest: None declared

Ethical approval: The study was approved by the institutional ethics committee

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