ORIGINAL ARTICLE

Early outcome of polymethyl methacrylate augmented dynamic hip screw in old age Osteoporotic patients with Trochanteric fractures

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Abstract

Background: Intertrochenteric fractures are common in elderly patients with osteoporosis, and for stable trochanteric fracture patterns, dynamic hip screw (DHS) has been the standard treatment. Complications like lag screw cut out and in-adequate bone anchorage, are frequent in osteoporotic patients. Despite the fact that polymethyl methacrylate (PMMA) augmentation has been commonly used to facilitate fixation, there are very few studies regarding its outcome.

Material and Methods: Total 73-patients of Trochanteric fractures with diagnosed Osteoporosis were included. The clinical outcome was rated as per the Salvati and Wilson scoring system at 6-months. Final radiological assessment was included any non-union and/or mal-union, screw cut out and breakage of implant, osteonecrosis of the femoral head, and the level of sliding collapse. Descriptive statistics was done, stratification was done and post-stratification student chi square test was applied considering p-value ≤ 0.05 as significant.

Results: There were 38.4% male and 61.6% female patients. Mean t-score on Dexascan was 2.83±0.21. Mean union time was 9.09±1.74 months. Mean Salvati and Wilson assessment score was 33.00±4.77. In our study, excellent outcome was 74%, good outcome was 21.9%, and poor outcome was 4.1%.

Conclusion: Polymethyl methacrylate (PMMA)-augmented hip screw is a useful option in trochanteric fractures with 74% excellent outcome.

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Introduction:

In order to reduce the effects of long term recumbence among patients of trochanteric fractures, surgical management is required to return the pre-fracture health of such patients. Ideally, this may be done with primary stabilization via dynamic hip screw (DHS). Nonetheless with patients having osteoporotic fractures, this method is not always successful. Reduced density of the bone and thin cortex of the bone are major problems that are faced among the patients with hip fractures. These factors account to failure of treatment among geriatric patients based on excessive collapsing tendency and cut-out of lag screw from superior aspect.[1-3] Initially, fracture site reduction through internal fixation may appear adequate, but upon weight bearing collapse into varus can result in treatment failure.[4] After such fractures and fixations, the quality of bone defines mechanical stability of the bone, and is also influenced by the type of fracture, reduction quality and the implant chosen.[5]

Historically, several treatment modalities, which include valgus-osteotomy, valgus reduction with tension-band wiring, lateral wall reconstruction, as well as a variety of other techniques have been adopted in order to improve the prognosis of these fractures.[6-9] There as on that none of the semethods have proved to be successful in case of these fractures is the superior screw cut out.[8,9] The use of polymethyl methacrylate (PMMA)

has not gained much acceptance despite being reported in several studies for fixation of unstable trochanteric fractures. An important reason of this un-acceptability could be delayed or failed union.[9-12] Inter-trochanteric fractures are common in elderly patients with osteoporosis. Previous studies show sresult of locking plates in patient with osteoporosis.[7,13-15]

Objective: There are only few studies that shows result of Dynamic hip screws with cement augmentation, therefore the aim of this study is to evaluate the functional and clinical outcomes of dynamic hip screws with cement augmentation in osteoporotic patients.

Operational definition:

Dynamic hip screw: It is a type of orthopedic implant designed for fixation of extra-articular hip fractures which allows controlled dynamic sliding of the femoral head component along the construct.

Polymethyl Methacrylate (PMMA): It is a transparent thermoplastic, synthetic polymer of methyl methacrylate that hardens and acts like adhesive cement when mixed with solvent.[13]

Material and Methods:

Study design: Retrospective cohort study

Study setting: Department of Orthopedics, Liaquat National Hospital, Karachi.

Study population: Patients who were admitted at Liaquat National hospital from January 2021 to December 2021 with diagnosis of inter-trochanteric fracture.

Inclusion criteria is inter-trochanteric fractures in either gender with age 60 to 80 years and diagnosed osteoporosis (T-score < 3.5 on DEXA scan). Exclusion criteria is patients with open fractures, sub-trochanteric fracture, reverse oblique fracture pattern, intra-capsular fracture of neck of femur, pathological inter-trochanteric fractures, and multiple fractures in same patient that will restrict early rehabilitation, patients with medical conditions that cannot undergo fracture surgery, were excluded from the study.

Study duration: Study was conducted from January 2021 to December 2021.

Sampling size: 73-patients with confirmed diagnosis of inter-trochanteric fracture were included in the study.

Sampling technique: Non-probability consecutive sampling technique.

Data collection: Patients opted were both males and females and 60 to 80 years of age. Patients with diagnosed osteoporosis (T-score < 3.5 on DEXA scan) were included and DEXA scan (dual energy X-ray absorptiometry) was used to assess mineral density of the bone. Classification of the fractures was done upon AO Muller classification. After dynamic hip screw (DHS), regular follow ups were done at regular intervals of time. For the initial 6-months, monthly visits were done for progressive assessment of union. Post-operative radiological assessment was done based upon degree of sliding, varus collapse and fracture union. The clinical outcome was rated as per the Salvati and Wilson scoring system at 3-months.

Data analysis: Patient's data will be compiled and analyzed through statistical package for social sciences (SPSS) version 25. Quantitative variables were presented by frequency and percentages like gender, mode of injury, and fracture classification. Quantitative variables were presented by mean and SD for age, T-score, number of days elapsed since surgery, union time, and Salvati and Wilson score. Stratification was done on gender, age, mode of injury and fracture classification by using chi square test. P-value<0.05 was treated as significant. Approval for study from institution will be obtained prior to the study.

Results:

Total 73 patients of either gender with age 60 years to 80 years meeting inclusion criteria of study were evaluated to determine the fre-

Table 1: Frequency distribution of fracture classification

Fracture Classification	Frequency (%)
31-A1.1	2 (2.7)
31-A1.2	5 (6.8)
31-A1.3	4 (5.5)
31-A2.1	11 (15.1)
31-A2.2	31-A2.2
31-A2.3	2 (2.7)
31-A3.1	11 (15.1)
31-A3.2	14 (19.2)
31-A3.3	10 (13.7)

Table 2: Frequency distribution of outcome

Outcome	Frequency (%)
Excellent	54 (74)
Good	16 (21.9)
Fair	3 (4.1)
Poor	0 (0)

Table 3: Salvati and Wilson assessment score according to outcome

	Excellent (n=54)	Good (n=16)	Fair (n=3)
Mean	35.38	27.37	20.00
SD	2.21	*1.89*	2.00
Median	36.00	*27.00*	20.00
Range	6	*6*	4
Minimum	32	*24*	18
Maximum	38	*30*	22

quency of outcome of polymethyl methacrylate (PMMA) augmented dynamic hip screw in old age osteoporotic patients with trochanteric fractures.

Descriptive statistics were calculated using SPSS. Stratification was done and post-stratification chi square test was applied to observe the effect of modifiers on outcome. P value ≤0.05 was considered as significant. Among 73-patients, 38.4% were male and 61.6% were female. Mean age was 69.32±6.14 years. The overall mean T-score on dexascan and number of days elapsed since injury was -2.83±0.21 and 10.16±2.16 days respectively. The overall mean union time and follow up duration was 9.09±1.74 months and 2.47±0.45 months respectively. Among 73-patients, 82.8% were caused injury by fall and 17.8% by road traffic accident (RTA). Most of the patients (19.2%) were classified as fracture type 31-A2.2 and 31-A3.2. The detailed frequency distribution of fracture classification is presented in table-1.

The overall mean Salvati and Wilson assessment score was 33.00±4.77. In our study, 74% of patients were found with excellent, 21.9% with good and 4.1% with fair outcome as presented in table-2.

Descriptive statistics of age, T-score on dexascan and Salvati and Wilson assessment score according to outcome were done. Descriptive statistics of Salvati and Wilson assessment score according to outcome are given in table 3.

Stratification with respect to gender, age group, injury mode, and fracture classification was do not observe effect of these modifiers on outcome. P-value ≤0.05 was considered asignificant. The results showed insignificant association of outcome with gender (p=0.244), age group (p=0.617), injury mode (p=0.499) and fracture classification (p=0.828).

Discussion:

Inter-trochanteric fractures in osteo-porotic patients influence the holding power of a screw by an increase in porosity of the bone. With the use of sliding hip screw devices, the frequency of screw penetration through the femoral head has significantly decreased. However, it is still common in osteo-porotic bones. Hence, an operative technique, permitting early ambulation, without consequent complications is desired. Benefits of an intra-medullary sliding screw devices were decrease in the incidence of excessive medial migration of the distal fragment and superior cut out due to its shorter lever arm. However, the above mentioned complications have not been completely excluded as these devices carry their own set of complications.

The use of adjunctive bone cement has been described by Harrington,[10] Muhr et al.,[12] and others, where cement provided a supporting strut in the post-eromedial cortical defect. However, the excessive cement used seeps into the frac-

Table : Salvati and Wilson score

	Pain
0	Constant and unbearable. Frequnt strong analgesia
2	Constant but bearable. Occasional strong analgesia
4	Nil or little at rest. With activities
6	Little pain at rest. Pain on activity
8	Occasional slight pain
10	No pain
	Walking
0	Bedridden
2	Wheel chair
4	Walking frame
6	One stick, limited distances up to 400 yards
8	One stick, long distances
10	Unaided and unrestricted
	Muscle power and motion
0	Ankylosis with deformity
2	Ankylosis with good functional position
4	Poor muscle power. Flexion < 60° abduction < 10°
6	Fair muscle power. Flexion < 60 - 90° abduction < 10 - 20°
8	Good muscle power. Flexion > 90° abduction > 20°
10	Normal muscle power. Full range of movement
	Function
0	Bed ridden
2	House bound
4	Limited house work
6	Most house work, can shop freely
8	Very little restriction
10	Normal activities

Grading of results

Score > 31 = Excellent, 24 - 31 = good, 16 - 23 = fair, < 16 = poor

ture site causing delayed union or non-union. Complete sliding of the lag screw may also be prevented, thus converting this dynamic implant into a static one. In a study by Lee et al. using cement augmentation with DHS, the average union time was 18.1 weeks. Cheng et al. also reported that, in their series of inter-trochanteric fractures, complications were due to excessive amount of polymethyl methacrylate cement and in-appropriate placement. Heini et al. studied the role of polymethyl methacrylate (PMMA) cement augmentation in osteoporotic bones in an experimental study on cadaveric femora. They concluded that polymethyl methacrylate (PMMA) augmentation significantly improved the cut out strength of the fixation by 42%. It was supported in our study, as there were no cases of implant migration or loosening despite of diagnosed osteo-porosis and early weight bearing.

The cement's primary functions were to fill in the gaps within the metaphyseal bone and strengthen the holding around the metal implants in the osteo-porotic bone. Thus, preventing screw cut out by providing anchorage to the lag screw in the femoral head. In our study there were no cases of non-union. To avoid the cement penetration into the fracture zone, the amount of cement used should be limited (approximately 4-5ml) and a special injection gun with a long nozzle should be introduced into the femoral head. Another known concern of polymethyl methacrylate (PMMA) is thermal damage. It is proposed that there is blockage of the normal endosteal blood circulation due to cement filling the intra-medullary canal. Therefore, it is essential to inject a limited amount of cement only into the femoral head area, as done in our study.

Bone cement like calcium phosphate which are relatively newer, resorbs over time and hardens without generating heat decreasing the thermal damage. Compressive strength of calcium phosphate appears sufficient, but the bending forces and shear strengths are on the lower side. The downside is less stiffness and quick resorption rate, with possibility of early cement failure before bone healing. On the other hand, polymethyl methacrylate (PMMA) is inert and non-bio-degradable, having like hood of persisting within the femoral head forever, which may influence the bone re-modeling. Thus, it is encouraged that polymethyl methacrylate (PMMA) augmentation is beneficial in patients with osteo-porosis and limited life expectancy, until long term results are presented.

Conclusion:

The study indicates that polymethyl methacrylate (PMMA)-augmented hip screw in osteoporotic patients with trochanteric fractures is a convenient option. Our study has a limited number of patients and absence of a control group. Therefore, studies with long term follow

up period and relatively large sample size are required before this procedure is advocated for a wider application.

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Role and contribution of authors:

Noman Khan, conception, manuscript writing and study design.

Sobia Aziz, literature review and manuscript writing.

Arslan Ahmed Abro, proof reading, data analysis, and interpretation of data.

Usman Mahmood, proof reading, data analysis, and interpretation of data.

Muhammmad Kazim Rahim Najjad, data collection and literature review.

Shahid Noor, proof reading.

References:

1. Bucholz RWHJDC-BCMRCAGDP. Rockwood and Green's fractures in adults. Philadelphia: Lippincott Williams & Wilkins; 2006.
2. Bridle SH, Patel AD, Bircher M, Calvert PT. Fixation of intertrochanteric fractures of the femur. A randomised prospective comparison of the gamma nail and the dynamic hip screw. J Bone Joint Surg Br. 1991;73(2):330-4.
3. Adams CI, Robinson CM, Court-Brown CM, McQueen MM. Prospective randomized controlled trial of an intramedullary nail versus dynamic screw and plate for intertrochanteric fractures of the femur. J Orthop Trauma. 2001;15(6):394-400.
4. Green S, Moore T, Proano F. Bipolar prosthetic replacement for the management of unstable intertrochanteric hip fractures in the elderly. Clin Orthop Relat Res. 1987(224):169-77.
5. Bonnaire F, Weber A, Bösl O, Eckhardt C, Schwieger K, Linke B. ["Cutting out" in pertrochanteric fractures--problem of osteoporosis?]. Unfallchirurg. 2007;110(5):425-32.
6. Hersche O, Heim D, Bodoky A, Regazzoni P. [4 fragment fractures of the proximal femur: is the dynamic hip screw a suitable implant?]. Helv Chir Acta. 1989;56(4):577-80.
7. Gupta RK, Sangwan K, Kamboj P, Punia SS, Walecha P. Unstable trochanteric fractures: the role of lateral wall reconstruction. International orthopaedics. 2010;34(1):125-9.
8. Clark DW, Ribbans WJ. Treatment of unstable intertrochanteric fractures of the femur: a prospective trial comparing anatomical reduction and valgus osteotomy. Injury. 1990;21(2):84-8.
9. Bartucci EJ, Gonzalez MH, Cooperman DR, Freedberg HI, Barmada R, Laros GS. The effect of adjunctive methylmethacrylate on failures of fixation and function in patients with intertrochanteric fractures and osteoporosis. J Bone Joint Surg Am. 1985;67(7):1094-107.
10. Harrington KD. The use of methylmethacrylate as an adjunct in the internal fixation of unstable comminuted intertrochanteric fractures in osteoporotic patients. J Bone Joint Surg Am. 1975;57(6):744-50.
11. Schatzker J, Ha'eri GB, Chapman M. Methylmethacrylate as an adjunct in the internal fixation of intertrochanteric fractures of the femur. J Trauma. 1978;18(10):732-5.
12. Muhr G, Tscherne H, Thomas R. Comminuted trochanteric femoral fractures in geriatric patients: the results of 231 cases treated with internal fixation and acrylic cement. Clin Orthop Relat Res. 1979(138):41-4.
13. Sari A, Alkan C, Karaipekli A. Preparation, characterization and thermal properties of PMMA/n-heptadecane microcapsules as novel solid-liquid microPCM for thermal energy storage. Applied Energy. 2010;87(5):1529-34.
14. Salvati EA, Wilson PD, Jr. Long-term results of femoral-head replacement. J Bone Joint Surg Am. 1973;55(3):516-24.
15. Johnell O, Kanis J. Epidemiology of osteoporotic fractures. Osteoporos Int. 2005;16 Suppl 2:S3-7.