Is distal femoral locking plate the implant of choice to fix all types of Distal femoral fractures?

Mian Amjad Ali, Khurram Iqbal, Faaiz Ali Shah, Shams ur Rehman, Syed Amjad Hussain

ABSTRACT

Objective: To determine the radiological and functional outcome of different types of distal femoral fractures fixed with locking plates.

Methods: This descriptive case series study was conducted at Department of Orthopaedic & Traumatology, Lady Reading Hospital Peshawar from February 2015 to June 2018. Patients of either gender or age with different types of distal femoral fractures fulfilling the inclusion criteria and fixed with distal femoral locking plates were enrolled into the study. Post-operative follow up visits were carried out at 4th week, 6th week and then monthly for 06 months and then every 3rd month till 02 years. Radiological and functional evaluation was done with modified Mize outcome criteria and graded as excellent, good, fair and failure.

Results: A total of 107 patients with mean age 44.57 ±SD12.03 years were operated with distal femoral locking plate. Only 6(5.6%) patients were lost to follow up and thus excluded from the study. Male patients were 68(67.3%) while female was 33(32.6%). Intra articular multifragmentary (33-C3) was the predominant fracture present in 29(28.7%) patients. Majority (n=85,8.1%) of the patients had excellent outcome as assessed with modified Mize outcome criteria while good outcome was achieved in 16(15.8%) patients. No non-union or implant failure was reported.

Conclusion: Distal femoral locking plates produced an excellent radiological and functional results in majority of the patients with different types of the distal femoral fractures. We recommend locking plate as an implant of first choice to fix all types of the distal femoral fractures.

Key Words: Distal femoral fracture, locking plate, outcome.

This article may be cited as:

INTRODUCTION

Fracture of the distal femur accounts for 6% of all femur fractures [1]. Younger males of 20 to 45 years old with high energy trauma like road traffic accidents and sports injuries and female over 60 years old, osteoporotic with simple fall are more prone to sustain these fractures [2,3]. Because of the extension of these fractures into the knee joint, presence of comminution, soft tissues and quadriceps injury, these fractures are a challenge to Orthopaedic surgeons [4]. The implants used to fix these fractures are angle blade plate, dynamic condylar screw, intramedullary nails, external fixator and primary arthroplasty [5,6]. Due to low bone quality and fracture comminution, conventional screw plate implants used to fix these fractures often fail while retrograde nailing not only require arthrotomy but protrusion of nail into the knee joint and knee stiffness have been reported [7]. Moreover, accurate articular surface reduction of fracture fragment is not possible with these implants [3]. Due to a number of biomechanical advantages, distal femoral locking plates is now a day the implant of choice to fix all distal femoral fractures [3,8]. Distal femoral locking plates are associated with a much lower incidence of fixation loss than angled blade plate and retrograde nailing because they can absorb much energy before failure [9,10].

Locking plates bridge comminution in metaphyseal region and act as internal fixator while multiple screws provide secure fixation in osteoporotic bones [11]. The resistance to plate pull out is equal to the sum of all locking screws resistance rather than single screw pull out as in case of conventional plate

Department of Orthopaedics & Traumatology,
Lady Reading Hospital, Peshawar, Pakistan.
Correspondence: Faaiz Ali Shah
Email: faaizalisha@yahoo.com

and screws [4]. The multiple fixed angle locking screws in the distal condylar portion of femur prevents collapse of the fracture in varus position which is otherwise reported with conventional plate and screws [12].

The objective of this study was to assess the radiological and functional outcome of all distal femoral fractures treated with distal femoral locking plates.

METHODS

This descriptive case series was conducted at Department of Orthopaedic & Traumatology, Lady Reading Hospital Peshawar from February, 2015 to June, 1018. The study protocol was approved by the Institution Review board of the hospital. Patients of either gender,18 years and above with distal femoral fractures (AO**[13]** types A, B, C) closed or open (Gustillo Anderson [14] Type I, II) presented within a week were included in our study.AO fractures type 33-A1.1 (apophyseal) and 33-B3 (Frontal), Polytrauma patients, pathological fractures, periprosthetic fractures, floating knee and vascular injury patients were excluded. Patients were admitted through Accidents and Emergency Department where initial resuscitation was done through ATLS protocol. X-ray knee joint, femur and hip joint were done in AP and lateral position. 3D CT scan was done in case of intraarticular fractures. Closed fractures were stabilized with long back slab while open fractures were stabilized with tibial Stienmann pin traction after thorough wound wash and parenteral antibiotics were given. Informed written consent for participation in study and thereafter publication was taken from all the patients. Detailed history and clinical examination was carried out in all patients and recorded on proforma. Closed fractures were operated on next available operation list while open fractures were operated once the wounds healed in average within 07 days.

All the patients were operated by the same surgical team. General or spinal anaesthesia was used with the patient in supine position with a tourniquet and pillow under the affected side knee and hip joint. Pre-operative intravenous antibiotic (1.5 gm Cefuroxime) was administered to all the patients. Through lateral distal thigh incision fracture was exposed. Intrarticular fragments were provisionally fixed with K wires in cases of communition. Locking plate was applied with at least 8 cortices proximal to the fracture. The wound was closed in layers with a suction drain. Static knee hip exercises were started on first post-operative day. Post-operative antibiotic (Injection Sulbactum + Cefoperazone 2 gm) intravenously twice daily was administered for 5 days to all the patients. Drain was removed after 24-48 hours and check x-rays were done. Stitches were removed at two weeks. Follow up visits were done at 4^{th}week, 6^{th} week and then monthly for 06 months and then every 3^{rd} month till 02 years. - At 12^{th} week follow up visible callus on X-ray indicated fracture union. Fracture that failed to unite within 8 months were classified nonunion [15,16].

Weight bearing was allowed once callus formation was visible on X-ray. Radiological and functional outcome was evaluated through modified Mize outcome criteria [17] Table 1 and graded as excellent, good, fair and failure. Alignment was determined by measuring the anatomic lateral distal femoral angle (normal range = 79°–83°) [17]. Statistical analysis was done by using SPSS version 20. Categorical variables like fracture type and gender was represented as frequency and percentage while mean±SD was calculated for numerical variables like age. Data was presented in tables where necessary.

Table I: Modified Mize outcome Criteria.

Grading	Description
Excellent	All of the following: loss of flexion, <10°; full extension; no varus, valgus, or rotatory deformity; no pain; perfect joint congruency
Good	No more than any 1 of the following: loss of flexion, >20°; loss of extension, >10°; varus deformity, >5°; valgus deformity, >10°; minimum pain
Fair	Any 2 of the criteria listed in the previous category
Failure	Any of the following: flexion, ≤90°; varus deformity, >10°; valgus deformity, >15°; joint incongruency; disabling pain, irrespective of radiographic appearance

RESULTS

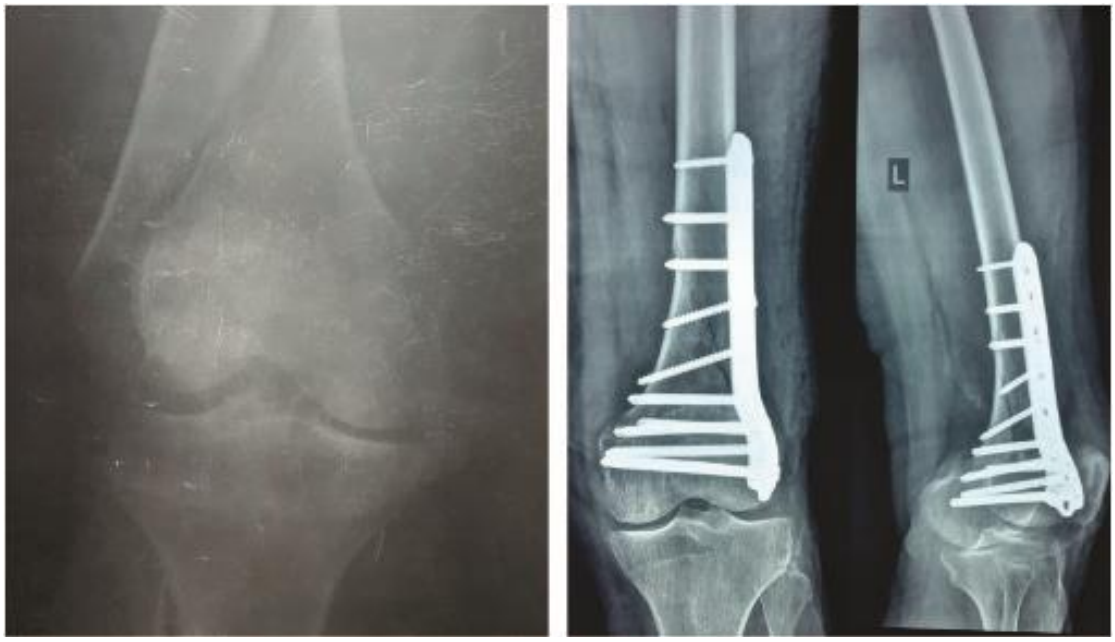
A total of 107 patients with mean age 44.57 ±SD12.03 years were operated with distal femoral locking plate. However, 101 patients completed the study as 6(5.6%) patients were lost to follow up and thus excluded from the study. Male patients were 68(67.3%) while females were 33(32.6%). Majority (n=61,60.3%) of fractures

were of right side while 40(39.6%) patients had left side fractures. The aetiology of fractures were road traffic accidents in

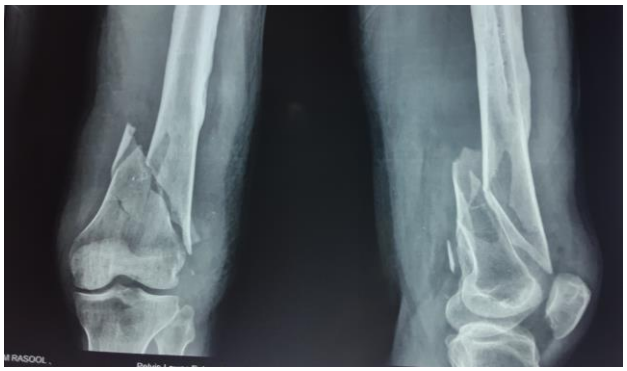
56(55.4%), fall in 27(26.7%) and gunshot injury in 18(17.82). Majority (n=78, 77.2%) of fractures were closed while 23(22.7%) were open. The AO types of fractures are shown in table II. Intra articular multifragmentary (33-C3) was the predominant fracture present in 29(28.7%) patients. Spinal anaesthesia was used in 71(70.2%) patients for surgery while general anaesthesia in 30(29.7%) patients. The average operating time was 65 minutes (range 45-110 minutes). Mean hospital stay was 8 days (range 4 to 15 days). Average union time was 16.3 weeks (range 12.2 to 24.5 weeks). Primary bone grafting was done in 13(12.8%) patients. Majority (84.1%) of the patients had excellent outcome as assessed with modified Mize outcome criteria while good outcome was achieved in 16(15.8%) patients. Majority (79%) of the fractures were not C3. Fair and failure outcome was not reported in our study. Superficial infection was observed in 4(3.9%) while deep infection was seen in 2(1.9%) patients. Superficial infection was resolved with antibiotics while deep infection was resolved after plate removal once union was achieved. No shortening, non-union, malunion, implant failure and in hospital mortality was reported. Plate removal was done in 48 (47.5%) patients (after 16 to 18 months in patients with deep infection, pain or patient wish).Majority(27%) of patients with plate removal had A3 fractures while no plate was removed from C3 fractures. No re-fracture was reported after implant removal up to 6 months post operatively. The mean follow up period was 28 months (range 24 to 30 months).

Table II: Frequency of various AO types of distal femoral fracture

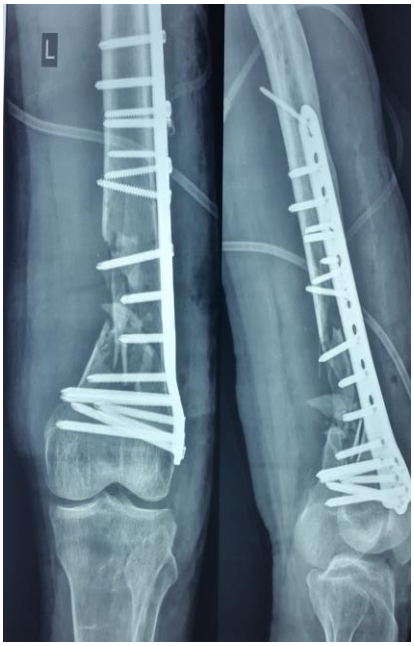
AO Type of fracture	Description	Frequency (patients)	Percentage
33-A1	Extra articular simple	11	10.8
33-A2	Metaphyseal wedge	6	5.9
33-A3	Metaphyseal complex	15	14.8
33-B1	Partial articular lateral sagittal	7	6.9
33-B2	Medial sagittal	2	1.9
33-C1	Complete articular simple	12	11.8
33-C2	Metaphyseal comminution	19	18.8
33-C3	Multifragmentry	29	28.7



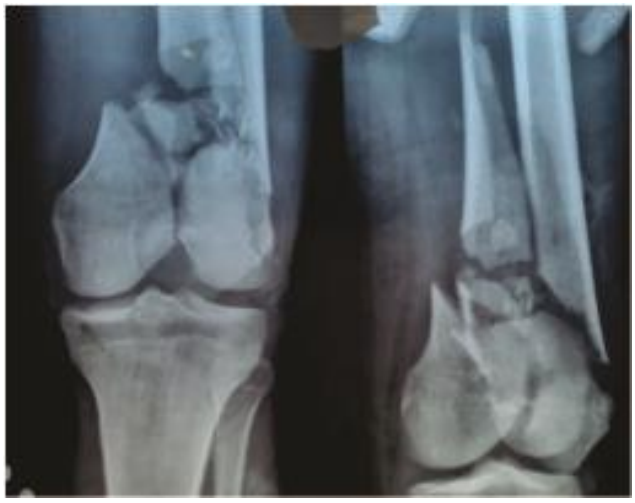
Case 1: A. Extra articular fracture distal femur B. Fixation with Distal femoral locking plate



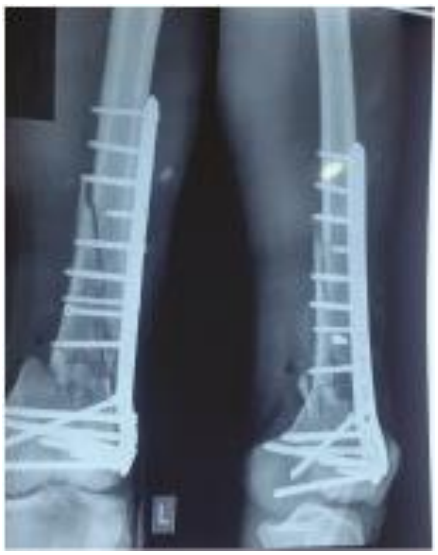
Case 2: A. Distal femoral fracture



B: Fixation with distal femoral locking plate



Case 3: A. Distal femoral fracture



B: Fixation with distal femoral locking plate.

DISCUSSION

We achieved excellent radiological and functional outcome in majority (n=85, 85.1%) of our patients with different types of distal femoral fractures fixed with locking plates. Good outcome was noted in 16(15.8%) patients while fair and failure outcome was not reported. Similar to our study Gupta [18] documented excellent results in 34 (85%) patients, good in 4 (10%) patients and failure in 2 (5%) patients treated with distal femoral locking plates. Trivedi [4] treated 25 patients of distal femoral fractures (AO C types) with locking plates and reported excellent outcome in 8(32%) patients, satisfactory in 8(32%), unsatisfactory in 3(12%) and failure in 6(24%) patients. Rajaiah [3] treated 20 patients with locking plates and documented excellent outcome in 7(35%) patients, good outcome in 8(40%), fair in 4(20%) and poor outcome in 1(5%) patient. He observed that young patients produced better results than older patients and type C fractures took longer time to unite than type A fractures. He concluded that distal femoral locking plate is an excellent device to fix these fractures with excellent radiological and functional outcome. This study only emphasis is that type C fractures take longer time to unite than other fractures. Our outcome evaluation are for all types of fractures as a whole which comprises 28.7% C3 fractures and 70.9% other fractures. So, majority of fractures were not C3. This can be the weakness in the study by not correlating the outcome with individual type of fracture. Variable results in literature might also be due to other factors

which need to be minimized with large scale well designed Randomized Control Trials. Our study design was descriptive and our sample size is larger than Rajaiah's study. We did not noted any implant failure which is a good sign as all fractures had been fixed with ideal implant and in accordance with biomechanical principles of fracture fixation. In one recent study Saini [19] and colleagues reported excellent outcome in 21(62%), satisfactory in 11(32%) and unsatisfactory results in 2(6%) patients. The outcome assessment criteria in most of these studies was Neer while we used Modified Mize outcome Criteria which is comprehensive and simple to use. Although Saini reported excellent results in 62% of patients,it is still inferior to our results. Again, this difference in results might be in evaluation of results by different criteria and large difference in sample size. In our study, superficial infection was reported in 4(3.9%) while deep infection was reported in 2(1.9%) patients. Two patients with deep infection had Gustilo Anderson type IIIA fractures while one patient with superficial infection had type II fracture. Variable rate of infection is reported in literature. Rajaiah [3] reported infection in 2(10%) patients, Trivedi [4] in 2(8%) and Poole [5] in 2(2%) patients. Nonunion was not reported in our study but in literature Reddy [2] reported nonunion in 2(3.3%) patients, Trivedi [4] in 1(4%) patient, Poole [5] in 4(3%) and Toro [20] in 2(16.6%) patients. Toro and colleagues also reported 1(8.3%) patient with implant failure. They are of the opinion that short plates and inadequate number of locking screws are the most important technical pitfall of locking plates application. Ricci [21] studied 335 distal femur fractures fixed with locking and documented nonunion in 64(19.1%). He pointed out that diabetes, obesity, smoking, open fractures and short plate length are the risk factors for failure of fixation. He observed that plate length of less than 9 hole was associated with worst results. He therefore recommended longer plates to decrease plate stiffness and allow fracture fragment movement to promote healing. Rodriguez et al [22] have the same observations like Ricci and reported a nonunion rate of 9.8% in their 283 distal femoral fractures. They concluded that infection, obesity, open fracture and stainless-steel plates are the possible risk factors for nonunion. Another study [23] reported nonunion of 41% with stainless steel and 10 % with titanium locking plates. Henderson [8] searched the literature, reviewed 23 articles and concluded that overall complications of fracture healing with locking plates ranges from 0% to 32% with delayed union 0% to 15%, nonunion 0% to 19% and implant failure 0% to 20%.

In our study, we have not reported any mortality rate but interestingly a very high mortality rates of 25(22%) at 12 months was reported by Poole [5]. This can be explained by the relatively higher mean age (72.8 years) and possible co-morbid conditions of their patients than ours (mean age 44.57 years). However, we lost 6(5.6%) patients in our follow up period. We could not compare stainless steel locking plate with titanium plates in our study. Nor we could analyze any association of obesity, diabetes, smoking, plate length and other possible risk factors for infection, non-union and implant failure. We therefore recommend further large scale randomized trials to address these issues.

CONCLUSION

All extra articular and intra articular distal femoral fractures fixed with locking plates produce excellent radiological and functional results in majority of our patients. The patients are early mobilized without fear of implant failure or nonunion. The implant is associated with very few complications. We recommend distal femoral locking plate as an implant of choice to fix all types of distal femoral fractures.

REFERENCES

1. Martinet O, Cordey J, Harder Y, Maier A, Buhler M, Barraud GE. The epidemiology of fractures of the distal femur. Injury. 2000 Sep;31(3):62-3.
2. Reddy JAV, Chary NB. Functional Outcome of Distal End of Femur with Locking Compression Plate: A prospective study. Ann Int Med Den Res 2016;2(1):362-65.
3. Rajaiah D, Ramana Y, Srinivas K, Reddy SV. A study of surgical management of distal femoral fractures by distal femoral locking compression plate osteosynthesis. J Evid Based Med Healthc 2016; 3(66), 3584-3587.
4. Trivedi NP, Chauhan RH, Padhiyar DR, Gandhi SP. Outcome of fracture of intra articular distal femur treated with distal femur locking compression plate. Int J Res Orthop 2015 ;1(1):22-27.
5. Poole EC, Wilson GG, Guthrie HC, Bellringer SF, Freeman F, Guryel E et al. Modern distal femoral locking plates allow early weight bearing with a high rate of union and low rate of failure: Five year experience from a United Kingdom major trauma centre. Bone Joint J 2017 Jul;99-B:951–7.

6. Kayali C, Agus H, Turgut A. Successful results of minimally invasive surgery for comminuted supracondylar femoral fractures with LISS: comparative study of multiply injured and isolated femoral fractures. J Orthop Sci 2007 Sep;12:458-465.
7. Hartin NL, Harris I, Hazratwala K. Retrograde nailing versus fixed-angle blade plating for supracondylar femoral fractures: A randomized controlled trial. ANZ J Surg 2006 May;76(5):290-4.
8. Henderson CE, Kuhl, LL, Fitzparick DC, Marsh JL. Locking plates for distal femur fractures: Is there a problem with fracture healing? J Orthop. Trauma 2011 Feb;25 (1): 8-14.
9. Koval KJ, Hoehl JJ, Kummer FJ. Distal femoral fixation: a biomechanical comparison of the standard condylar buttress plate, a locked buttress plate and the 95-degree blade plate. J Orthop Trauma 1997 Oct;11:521–524.
10. Zlowodzki M, Cole PA, Williamson S. Biomechanical evaluation of the less invasive stabilization system, angled blade plate, and retrograde intramedullary nail for internal fixation of distal femur fractures. J Orthop Trauma 2004 Sep;18:494-502.
11. Greiwe RM, Archdeacon MT. Locking plate technology: Current concepts. J Knee Surg. 2007 Jan;20(1):50-5.
12. Heather V, Theresa H, John S. Failure of LCP condylar plate fixation in the distal part of the femur. J Bone Joint Surg. 2006 Apr;88-A:846-53.
13. Marsh JL, Slongo TF, Agel J, Broderick JS, Creevey W, DeCoster TA, et al. Fracture and dislocation classification compendium - 2007: Orthopaedic Trauma Association classification, database and outcomes committee. J Orthop Trauma 2007 Nov-Dec;21(10): 1-133.
14. Gustilo RB, Mendoza RM, Williams DN. Problems in the management of type III (severe) open fractures: A new classification of type III open fractures. J Trauma 1984 Aug;24:742-6.
15. Gupta RK, Rohilla RK, Sangwan K, Singh V, Walia S. Locking plate fixation in distal metaphyseal tibial fractures: Series of 79 patients. Int Orthop2010 Dec;34(8):1285–1290.
16. Rodriguez-Merchan EC, Gomez-Castresana F. Internal fixation of nonunions. Clin Orthop Relat Res 2004 Feb;419:13–20.
17. Mize RD, Bucholz RW, Grogan DP. Surgical treatment of displaced, comminuted fractures of the distal end of the femur. J Bone Joint Surg. Am 1982 Jul;64(6):871–9.
18. Gupta GK, Dr. Rani S, Kumar R, Singh B. Analysis of management of supracondylar femur fracture by locking compression plate. International Journal of Orthopaedics Sciences 2016 Sep;2(4): 218-222.
19. Saini RA, Shah N, Sharma D. Functional outcome of distal femoral fractures treated with DF-LCP [Distal femur locking compression plate]. International Journal of Orthopaedics Sciences 2018;4(1): 439-444.
20. Toro G, Calabrò G, Toro A, de Sire A, Lolascon G. Locking plate fixation of distal femoral fractures is a challenging technique: A retrospective review. Clin Cases Miner Bone Metab. 2015 Jan-Apr;12(Suppl 1):55-58.
21. Ricci WM, Streubel PN, Morshed S, Collinge CA, Nork SE, Gardner MJ. Risk factors for failure of locked plate fixation of distal femur fractures: An analysis of 335 cases. J Orthop Trauma. 2014 Feb;28(2):83-9.
22. Rodriguez EK, Boulton C, weaver MJ, Herder LM, Morgan JH, Chacko AT et al. Predictive factors of distal femoral fracture nonunion after lateral locked plating: A retrospective multicenter case-control study of 283 fractures. Injury 2014 Mar;45(3): 554-559.
23. Rodriguez EK, Zurakowski D, Herder L, Hall A, Walley KC, Weaver MJ et al. Mechanical construct characteristics predisposing to non-union after locked lateral plating of distal femur fractures. J Orthop Trauma 2016 Aug;30(8):403-8.

AUTHORSHIP AND CONTRIBUTION DECLARATION

No	Author Name	Contribution to paper	Signature
1	Principal author Prof. Mian Amjad Ali	Revised the article critically for important intellectual content	
2	Second Author Dr. Khurram Iqbal	Data Collection & Interpretation	**Faaiz Ali Shah**
3	Third Author Dr. Faaiz Ali Shah	Conception & Design of the study	
4	Fourth Author Dr. Shamas Ur Rehman	Data Interpretation	
5	Fifth Author Dr. Syed Amjad Hussain	Final approval of the study for publication	