Result of treatment of distal femoral fractures with anatomic locking plate and screws in ISTH Irrua; case series.

Enoma O, Nwokike OC, Onuminya JE, Ogbue IA.

Department of Orthopaedics and Trauma, Irrua Specialist Teaching Hospital Irrua, Edo State, Nigeria.

Abstract

Background: Distal femoral fractures are common injuries that present to our facility. Road traffic Accident is the major etiological factor. There are several treatment options depending on the fracture personality. This ranges from non-operative to operative. Operative treatment includes anatomic locking plate and screws, intramedullary nailing, fixed angle blade plate and condylar dynamic screw. The result of treatment varies with the treatment methods employed. Our experience with the use of anatomic distal femoral locking plate in the treatment of distal femoral fracture has not been reported. Objectives: The aim of this report is to highlight the outcomes of distal femoral fractures with anatomic locking plate and screws in ISTH, Irrua, Edo State. Methods: We report the result of three cases of distal femoral fracture treated with anatomic locking plate and screws. Results and Conclusion: From these reports, we observed satisfactory outcomes with regards to fracture union following clinical and radiological evaluation.

Keywords*: Distal femoral fractures, operative treatment, anatomic locking plate, outcome.*

Introduction

The femur is the longest, strongest and heaviest tubular bone in the human body and one of the principal load-bearing bone in the lower extremity[1]. It has different parts, among which are the Proximal, shaft and distal parts. Fracture can occur in any of these parts[2]. Shaft fractures are generally caused by high energy injuries and are often associated with multi-systemic traumas [3], except if the bone has been weakened by other conditions such as pathologic fracture[4]. Younger patients generally present secondary to high energy mechanisms such as motor vehicle accidents, while elderly patients present typically after low energy mechanisms such as ground level fall. Elderly patients often present with significant co morbidities imparting their operability, recovery and survival[5]. Adult femoral fractures present a bimodal distribution pattern[6]. As the population ages, the treatment of these complex fractures has correlated poor outcome[7]. Other high energy injuries such as gunshot wound, fall from height, assault and injury from high-speed sport are often causes of fracture of the femur especially in young adult [8]

Corresponding author Dr. Osasuyi. Enoma,
Department of Orthopaedics and Traumatology,
Irrua Specialist Teaching Hospital Irrua. Edo State, Nigeria.
Email: osasuyienoma1974@gmail.com.
Phone no: +234 803 6500 200

Distal femur fractures include fractures of the supracondylar and intercondylar region of the femur extending from the metaphyseal–diaphyseal junction to the articular surface of the knee and are relatively common injuries. The femoral shaft is oriented in 7 to 11 degrees of valgus in relation to the knee joint. Maintaining this alignment is critical to the function and durability of the limb. In distal femoral fracture, the thigh musculature shortens and displaces the fracture into either varus or valgus, depending on the location of the fracture relative to the adductor tubercle. The gastrocnemius muscle cause apex posterior angulation of the distal fracture fragments with increased risk of major vascular injury and the two heads of the muscle may separate and rotate the femoral condyles in the event of intercondylar split [9].

Clinical assessment involves immediate identification and treatment of life-threatening problems using Advance Trauma Life Support protocol to achieve and maintain cardiovascular and cardiopulmonary stability when multisystem injury is involved. The initial assessment should include a systemic and physical inspection of the involved extremity for swelling, painful crepitus with motion and occasional deformity of the thigh is present. Also, assessment of neurovascular status should occur in every case. Open

fractures and other ipsilateral limb injury should be assessed as this too may influence surgical management, timing and implant choice. Standard radiographic imaging with two views of the fracture site should be done. Full length femur x-ray should be included which will exclude other fractures in the femur. In complex fractures, CT is used to delineate an intraarticular extension line in coronal plane. Open fracture occurs in 5% to 10% of supracondylar fractures, thus the skin should be meticulously examined for wound[10].

Complications and injuries associated with femoral fractures especially in adults can be life threatening and may include haemorrhage, internal organ injury, wound infection, fat embolism and adult respiratory distress syndrome[11]. In view of the above, treatment of femoral fracture should be prompt and appropriate otherwise such fracture can cause prolonged morbidity and extensive disability such as prolonged hospitalization, infection, inappropriate fracture union such as delayed union, malunion, non-union and implant failure[12]. The goals of treatment follow Arbeit gemeinschaft fur Osteosynthesefragen (AO) of anatomic reduction of articular surface, restoration of limb alignment, length and rotation.

Options of treatment include non-surgical and surgical fixation. Non-surgical management includes protected weight or non-weight bearing in an unlocked, hinged knee brace to maintain the range of motion. Indication for non- surgical management include distal femur fractures that are not displaced and stable as well as patient with medical conditions which preclude surgical treatment[13]. Surgical fixation has consistently demonstrated superior as compared with non-surgical treatment with respect to improvement in alignment, bony union, knee range of motion and functional outcome[14]. Methods of surgical fixation include external fixation, fixed angle blade plate, dynamic condylar screw, locking plates and intramedullary nails. These fixation types depend on the fracture characteristics and in addition to the overall medical condition of the patient[13]

Distal femoral locking plate and screws provides multiple point of fixed plate to screw contacts, generating greater stability than is provided by a single lateral construct, which potentially reduce the tendency for varus collapse[15]. Distal femoral locking plate decreases screw plate toggle and provides more stable fixation which is one of the key factors in the successful treatment of these complex fractures. This devise creates a fixed angle at each screw hole where the individual screw head is secured to the plate by a locking mechanism[16]. Since the plate does not depend on friction created at the bone–plate interface to provide stability, the plate does not have to contact the bone directly which help in preserving the periosteal blood supply[17]. Locking implants are typically indicated in patients with osteoporosis, fracture with metaphyseal comminution where the medial cortex cannot be restored or with a short articular segment[18]. Thus, the flexibility of locking condylar plate with its fixed angle properties appear to offer an effective alternative to implant like dynamic compression screw, condylar buttress plate and a supracondylar or a distal femur retrograde nail.

Good preoperative planning is essential and can minimize many of the intra or postoperative complications. It is important that during the initial assessment, a high index of suspicion for associated injuries to the chest, head, abdomen and spine should be made. Careful evaluation of the pelvis and all extremities for possible occult injuries should be done. Ligament instability of the knee can occur with fracture distal femur and often cannot be determined until after the fracture is stabilized. Careful evaluation of the neurovascular function is done, if vascular injury is suspected, arteriography is indicated[19].

We present three cases of complex distal femoral fractures treated with distal femoral locking plates.

Case 1

Mrs EA, 78 years old retired civil servant who presented to the Accident and Emergency unit of our facility following a fall on a wet floor. Had a twisted right knee, noticed severe pain, deformity and progressive swelling of the distal right thigh. She presented about an hour following injury. Radiograph shows fracture distal right femur AO/OTA (33-B2). She is a well-known diabetic and hypertensive compliant with her medications.

Pre-operatively, detailed history and examination were done. Had full blood count, electrolyte, urea and creatinine done which were within normal range. Eletrocardiogram and chest radiograph were normal. We critically assessed the qualities of fracture and appropriate implant was selected. The consent was

obtained for surgery, and she fasted the night before surgery.

Intraoperatively, with patient on radiolucent operative table, had epidural anesthesia and antibiotics (IV ceftriaxone 1gm) at induction. The entire limb was draped free into the field to allow manipulation of the extremity. With a triangular bolster below the knee, a direct lateral approach was used to expose the fracture site. Longitudinal skin incision 10 to 15cm, from above the fracture directly centered over the lateral epicondyle was made. It was long enough to allow gentle soft tissue retraction. The skin incision was gently curved to a point just lateral to the tibia tuberosity. This was determined preoperatively. The facia Lata was incised in line with its fibers exposing the vastus lateralis, which is reflected off the intermuscular septum along the Linea aspera in an anterior and medial direction. Perforators are identified and ligated. Wild soft tissue striping was avoided, and no soft tissue dissection was made on the performed on the medial side of the femur to minimize disruption of soft tissues. A retractor was placed under the vastus lateralis, and it was elevated medially to expose the distal femur and displaced the patella medially. Visualization of the articular surface of the lateral condyle was satisfactory. Extraarticular pattern was reduced by longitudinal traction; the use of a well-placed bump to flex the knee and the manipulation of fragment with clamps.

For intraarticular fracture pattern, reduction of the articular block by flexing the knee to 40 - 70 degree was done first before stabilization of the metaphyseal implant. The adequacy of reduction was confirmed both clinically and fluoroscopically, checking alignment, deformities and limb length. Appropriate screw length was applied. The surgical wound was close in layers with vicryl 2 for fascia and prolene 1 for skin after irrigation and securing of Redivac suction drain.

Post operatively, she had parenteral ceftriaxone 1g daily and pentazocine 30mg 6hourly for 5days before converting to orals medications. She also had wound drain removed and started range of motion exercise at 2nd day post-operative day and was subsequently ambulated with axillary crutches non weight bearing.

Patients were on antiDVT which was discontinued when ambulation was fully established. She was discharged home for outpatient visitation at 2weeks post-operative day after removal of suture. Partial weight was delayed until after 12 weeks post op during follow-up. Below are radiographs pre op., immediate post op. and at 6months post op. fig 1, 2 and 3. Follow up was done every 2, 4, 6 weeks post op. and subsequently, patient is followed up monthly for the next 3 months and then every 3 months for the following year. During this period, assessment of outcome was done using:

1) Fracture healing assessment based on radiological evaluation, considering progress of fracture healing and bone union.
2) Knee joint function assessment using the NEER score considering range of motion.
3) Presence or absence of pain using visual analogue Scale.

During each visit, plane radiography of the affected thigh with the knee joint is obtained and functional scoring is conducted with the help of NEER scoring [20]. This scoring involves both clinical and investigational parameters and is rated out of 100. A score above 85 is considered excellent, 70 – 85 satisfactory, 55 – 69 is unsatisfactory and a score below 55 is deemed failure[21]. Using this scoring system, this first case had a satisfactory outcome with a score of 84.

Radiological assessment of fracture healing was done using the modify RUST (mRUST) score[22]. In addition to the standard RUST score, mRUST further subdivides callus formation into simple present or bridged[23]. In mRUST score, each cortex is scored 1-4 on AP and lateral view, were 1 is no callus, 2 Callus present, 3 bridging callus and 4 Remodlled with no visible fracture line. The total score ranges from 4 to 16 for all four cortices [22]. This first case had a score of 16. Pain was assessed using the visual analogue scale (VAS). The present absence of pain determines the degree of fracture healing. VAS is a simple and frequently used method to evaluate variation in pain intensity[24]. Despite the diversity, VAS is widely used in literature and clinical practice. For this case, satisfactory outcome was obtained.

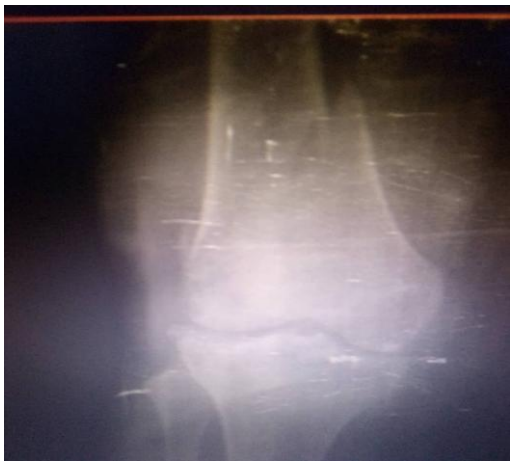

Fig 1 Pre op radiograph showing fracture medial condyle which extend to the articular surface AO/OTA (33-B2)

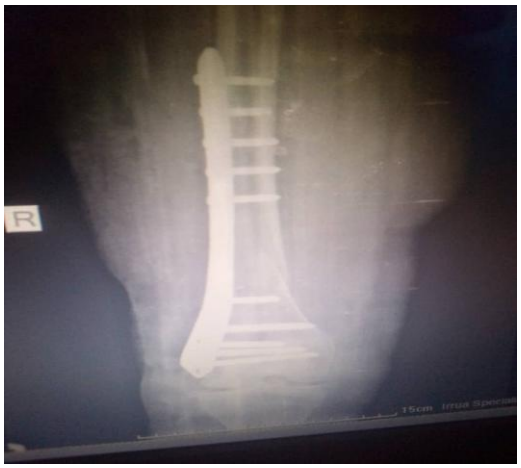

Fig 2 immediate post op showing well reducded fracture with anatomic plate

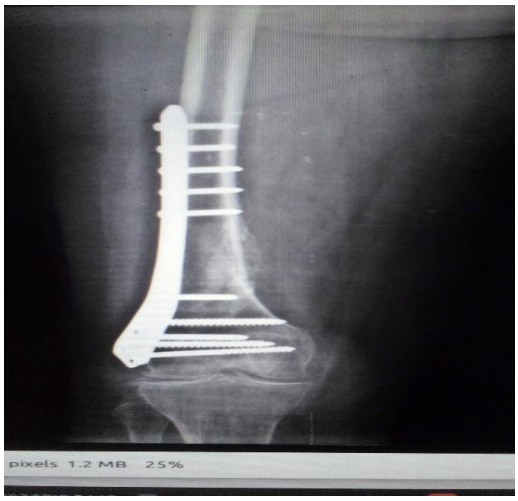

Fig 3 well formed callus or fracture healing

Case 2

Mrs. PA, 57-year-old staff, presented to the Accident and Emergency unit following a road traffic accident. She was the only passenger on a commercial motorcycle that had a head-to-side collision with another commercial motorcycle. She sustained close injury to the distal right thigh. There was no injury to any other part of the body. She is a known hypertensive also compliant with her medications. She is not diabetic. Had initial care at a private facility before her presentation. Radiograph shows comminuted fracture distal right femur AO/OTA (33-A2). She had pre-operative work up and open reduction and internal fixation with distal femoral locking plate and screws 10th days after presentation. Post operatively, a similar protocol with the first patient was adopted. The NEER score was 93 (excellent), mRUST was 93 and VAS shows satisfactory outcome.

Below are radiographs pre op, immediate post op and at 6months post op. fig. 1, 2 and 3.

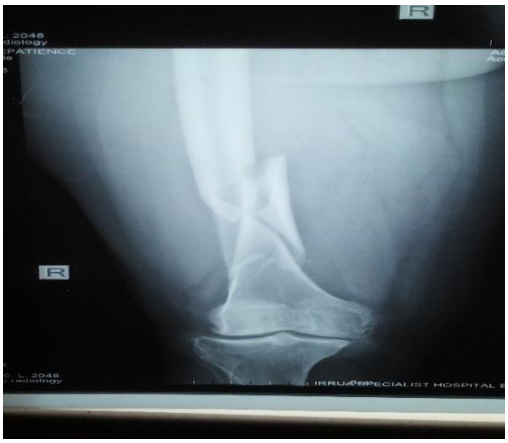

Fig 1 shows comminuted fracture distal femour extra articular AO/OTA (33-A2)

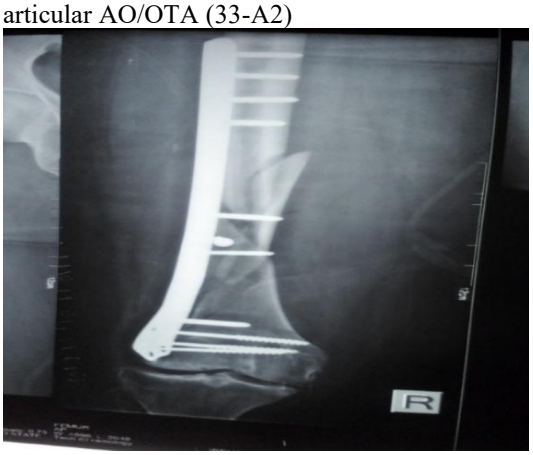

Fig 2 fixation with distal femoral locking plate and screws

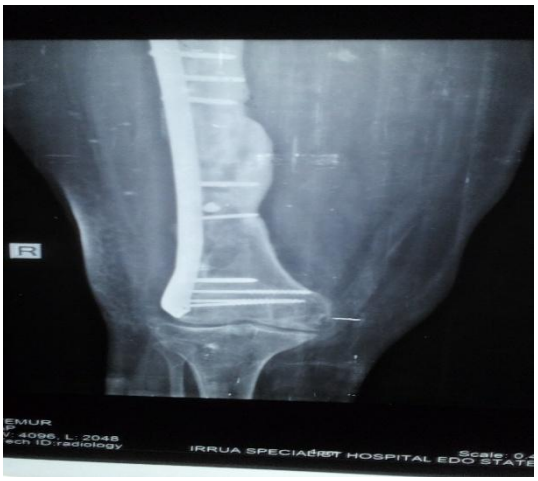

Fig 3 shows fracture healing with callus formation

Case 3

Mr. CE, 34 years old undergraduate student who presented the following road traffic accident. He was a passenger on a commercial motorcycle that had a head-to-side collision with a fast-moving vehicle. He sustained a close injury to the distal right thigh with deformity, pain and swelling. Plain radiograph showed distal right femoral fracture extra articular (33-A1). He had no co-morbid conditions. Pre, intra and post-operative protocol was like the previous cases 1. NEER score and mRUST were 93 and 16 respectively while the VAS was satisfactory.

Below is pre-op, immediate post op and 6months radiographs fig 1, 2 and 3 respectively.

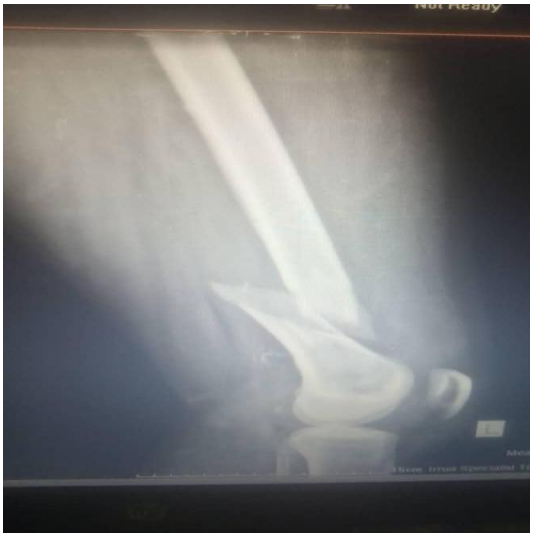
Fig 1 shows type 33-A1 fracture with posterior displacement

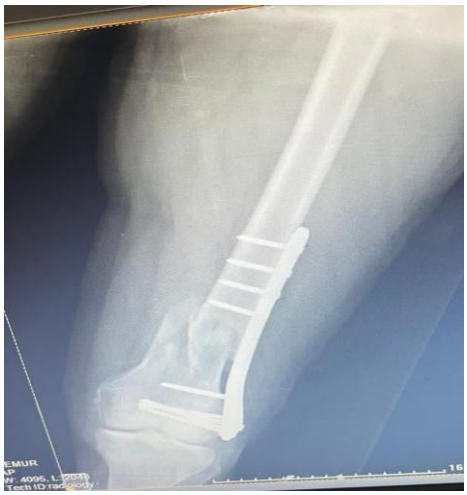
Fig 2. Immediate postop radiograph

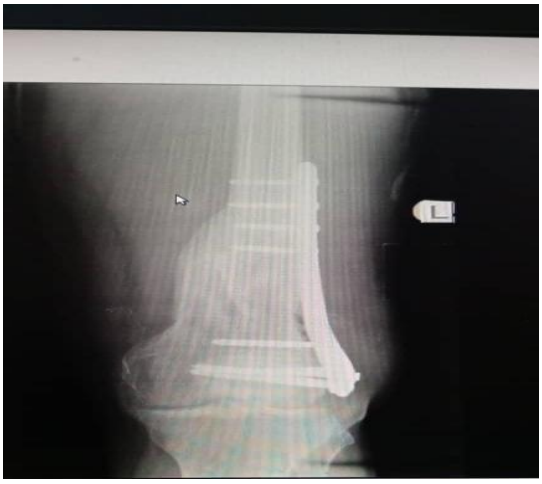

Fig 3; shows well Formed Callus and fracture healing

Discussions

Distal femoral fractures represent 3-6% of femoral fractures and 0.4% 0f all fractures [25, 26]. The literature appreciate a classical bimodal age distribution with younger patients more likely be male involve in high energy trauma and older patients are more likely to be female with injury sustained from low energy etiology such as fall from standing[27]. Etiology was also noted in our study. For older populations this effect is compounded with osteoporosis [28].

The most common mechanism involves direct trauma to flexed knees, typically seen in dashboard injuries during motor vehicular accidents. The deforming forces of distal femur fracture depend on the location of fracture relative to the adductor tubercle. Generally, the hamstrings and extensor mechanism cause fracture to

shorten, and the adductor maguns displaces the fracture into varus. The two heads of gastrocnemius muscle extend the distal fragment, resulting in an apex posterior angulation of the fracture. With intercondylar split fracture pattern, the two heads may also cause the distal condylar fragment to separate and rotate. Soft tissue injuries are often associated with distal femoral fractures. This may include ligament disruptions of the knee joint that are often difficult to diagnosis until distal femur fracture has undergone stabilization.

Distal femur fractures that result from a gunshot injury, high energy trauma, or open injury present a high risk of vascular injury. The femoral artery lies within the adductor canal.

From the cases presented, trauma was the main cause of distal femur fracture. The first case was due to low energy injury when compared to the other two which were due to high energy injury from Road traffic accident. In the study done by Tsegaye et al, similar result was also obtained, that the major etiological factor in distal femur fracture was high energy injury from bullet wound (65%), followed by road traffic accident (21.7%) and fall (13.3%). This is probably because commercial motorcycles are the means of transportation in our rural environment. They also noted that the left side was more involved (77%) and right (23%)[29]. This was in contrast with this report which was on the right side.

Fracture distal femur may be broadly classified as extra articular, intra articular unicondylar or intra articular bicondylar with subclassification for specific pattern and degree of comminution. The AO/OTA fractured classification system is the most universally used[30].

Fracture patterns are classified as type A (extra articular), B (partial articular/unicondylar) and type C (complete articular/ bicondylar). Sub-classification within fracture type A and C reflect the degree of comminution and instability. Type A2, A3 and C2 fractures involve metaphyseal comminution, whereas type C3 fractures are characterized by metaphyseal and intra articular comminution. Type B fractures are sub-classified based on the involved condyle; the lateral condyle is designated as B1 and the medial as B2. Coronal plane partial articular fractures (ie Hoffa) are designated as B3. Type C fracture may have condylar fractured lines in the coronal plane [25]. In our study, the three cases are type 33-B2, 33-A2 and 33-A1 fractures respectively

During radiological investigation, plane radiography should be obtained for suspected fracture of the distal femur. In more complex fractures, CT scan is used is used to delineate intraarticular extension, degree of comminution and line in coronal plane[32].

Definitive management of distal femoral fractures require maintenance or restoration of distal femoral alignment to preserve the fracture of extremity[25]. With intraarticular type C fractures, restoration of the congruity of the articular surface should be a priority and intercondylar fractures should be addressed initially[25]. Length, alignment and rotation should be evaluated clinically and fluoroscopically after reduction and before the implant is secured.

In a study done by Otto et al[32], distal femur locking plate was used in the treatment of patients. This was because locking plate leads to greater stability and endure higher load until hardware failure than conventional plate. With the locking condylar plate, we were able to achieve fracture union in all the cases along with satisfactory range of motion of the knee joint. Similar results were obtained by Rademaker et al[33] in their study. The mechanical advantage of screw head getting locked in the plate which converts the implant into a single solid angle stable construct makes it more useful in comminuted fractures and in osteoporotic bone. The combi hole in the plate offers the dual advantage of applying normal screws in a compression mode as well as locking screws in fractures where traditional screws purchase is compromised. This function of locked fixation and its angle stability help in sparing periosteal blood supply. Also, since no contouring of plate is required and the toggle at the screw plate interface is minimize the holding power of the implant is increase[34].

However, several recent studies have reported contrary opinion regarding failure of locking plate[35, 36].

Masaharo K. et al[37] reported that non-union was the main complication in their study. However, the three patients presented had satisfactory fracture healing without significant complications.

Some of the challenges we observed during this study were delay in patients giving consent for surgery and poor adherence to ambulation protocol.

Conclusion

Distal femoral fractures are common orthopaedics cases that present at the Accident and Emergency unit of Irrua specialist Teaching Hospital, Irrua.

Distal anatomical locking plate is still the main stay for the management of these fractures, especially those that are commuted with intraarticular extension. Early surgical intervention, good anatomic reduction during open reduction and internal fixation and post- operative care and follow up are crucial to achieving satisfactory outcome.

References

1. Ibenusi SE and J Chioma. Pattern and outcome of femoral fractures treated in a regional Trauma center in South South, Nigeria. Int Arch Orthop Surg 2019; 2(1):19-21.
2. Anyachie UE, Ejimofor DC, Akpuaka FC, Nwadinigwe CU. Pattern of femoral fracture and associated injuries in a Nigerian tertiary center. Nigerian Journal of clinical practice. 2015;18(4):p462-466.
3. Nork SE, Rockwood CA, Green DP, Bucholz RW, Fractures of the shaft of the femur Rockwood and Green fractures in Adult. 2006; 6th Philadelphia Lippincott Williams and Wilkins: 1846-914.
4. Moore KL, Agur AM. Clinically oriented Anatomy, (6th edn), Williams and Wilkins, Baltmore. 2009; 187- 221.
5. Matthew S. Coon; Ben J. Best. Distal femur fractures. National Library of Medicine. Statpearls July 31, 2023.
6. Martinet O, Cordey J, Harder Y, Maier A, Buhler M, Barrand GE. The epidermiology of fracture of distal femur Injury. 2000; Sep; 31 suppl 3:C62-3.
7. Shields E, Behrend C, Bair J, Cram P, Kate S. Mortality and financial Burden of periprosthetic fractures of femur. Geriatr Orthop Surg Rehabil .2014 Dec;5(4);147-53.
8. Sologbern BA, Udoffa US, Abdur-Rahman LO, et al. Epidemiology of Truama death. West Afr. J.Med 2003; 2: 177-181.
9. Winston Gwathmey, Jr MD, Sean M. Jones – Quadoo, MD, David Kahlar, MD, Shepard Hurwitz MD, Quanjun Cui, MD,. Distal femoral fracture; current concept. Oct 2010, vol 18, No 10; p 597-607.
10. Rock Wood and Green fracture in Adult, ed 6. Philadepia, PA, Lippincott, Williams, 2006; PP 1916-1967.
11. Arneson TJ, Melton LJ, Lewallen DG, O' Fallon WM. Epidermiologyof diaphyseal and distal femoral fracture in Rochester, Minnesota, 1965-1984. Clin Orth Relat Res 1988; 234:185-194.
12. Marsh D. Concepts of fracture union, delayed union and non union. Clin. Orthop Relat Res . 1998; (355): 522-530.
13. Von Keudell et al. Treatment options of distal femur fracture. Journal of Orthopaedic Truama. 2016; 30(.): P sS25-27, August 2016.
14. Butt MS, Krikler SJ, Ali MS. Displaced fracture of the distal femur in elderly patients. Operative versus non operative treatment. J Bone surg Br. 1996; 78: 110-114.
15. Mriganka NM, Girish BM. Competency of distal femur locking plate as an answer for fixation of all varieties of distal femur fractures. Int J Res Orthop. 2019 Jul; 5(4): 555-558.
16. Greiwe RM, Achdeacon MT. Locking plate Technology: current concept. J knee surg, 2007; 20: 50-55.
17. Perren SM. Evolution of internal fixation of long bone fractures. The scientific basis of biological internal fixation. Choosing a new balance blw stability and biology. J Bone Joint surg Br. 2002: 84; 1093-110.
18. Gautier E., Sommer C. Guidelines for the Clinical Application of the LcP. Injury. 2003; 34 (suppl 2); B63-76.
19. Chapman MW, Bray TJ, Spiegel PG. Green SA. Operative Orthopaedic; second Edition, JB. Lippincolt company, vol 1, 1993, P 651-662.
20. Neer CS, Grantham SA, Shelton ML. Suprachondylar fracture of the adult femur. A study of one hundred and ten cases. J. Bone Joint surg AM. 1967; 49(4):591-613.
21. Arshad ahmed et al. Study on the functional out-come of distal femoral fracture using NEER Score. Journal of clinical and diagnostic Research. 2024 May, vol 18(5): RCo6-RC 12.
22. litrenta J, Tornetta p 3rd, Mehta S et al. Determination of radiographic healing: An assessment of consistency using RUST and modified RUST in metadiaphyseal fracture J Orthop Trauma 2015; 29: 516-20.
23. Morshed S. Current option for determining fracture union. Adv Med 2014; 708574.
24. Chapman CR, Casey KL, Dubner R, Foley KM, Gracely RH, Reading A E. Pain measurement: an overview. Pain. 1985: 22(1): 1-31.
25. Gwathmey FW Jr. Jones-Quaidoo SM, Kahler D., Hurwits S,, Cu. Q.Distal femoral fractures. Current Concepts. J.AM. Acad. Orthop. Surg. 2010; 18(10):597-607.
26. Court Brown CM., Caesar B. Epidemiology of adult fractures. A review. Injury. 2006; 36(8): 691-697.
27. Martinet O.,Cordey J., Harder Y., Maier A., Buhler M., Barraud G.E. The epidemiology of fractures of distal femur; Injury. 2000; 31(suppl.3):C62-C63.
28. Rockvill, MD: US Department of Health and Human services. Bone health and osteoporosis: A report of surgeon General. USDHHS; 2004.
29. Tsegaye et al., Distal femoral fracture. Journal of Orthopaedics surgery and research (2024) 19: 582.
30. Marsh JI., Slongo TF., Agel et al: fracture and dislocation compendium; Orthopaedic Trauma association classification database and outcomes committee. J Orthop Trauma 2007; 21(10 suppl): S1-S133.
31. Nork SE., Segina DN., Aflatoon K et al: The association between supracondylar intercondylar distal femoral fractures and coronal plane fractures. J Bone Joint Surg Am 2005; 87(3): 564-569.
32. Otto RJ, Moed BR, Bledsore JG. Biomechanical comparism of polyaxial type locking plate and a fixed angle locking plate for internal fixation of distal femur fracture. J Orthop Trauma; 2009: 23:645-652.
33. Rademakers MW, Kerkhoffs GM, Sierevelt IN, Raaymakers EL, Marti RK. Intrasrticular fracture of distal femur, along term follow up study of gurgically treated patients. J Orthop Trauma. 2004; 18(4): 213-219.
34. Thomas P, Rued AD. Principle of fracture Management. New york: Thieme: 2000. PP. 181-82.
35. Granata JD, Litsky AS, Lustenberger OP, Probe RA, Ellis TJ. Immediate weight bearing of comminuted supracondylar femur fracture using locking plate fixation. Orthopaedics 2012:35: e 1210-1213.
36. Kujan TJ, Henderson CE, Madey SM, et al. Locked plating of distal femur fracture leads to inconsistent and asymmetric callus formation. J Orthop Trauma 2010: 24(3): 156-62.
37. Kiyono M, Noda T, Najano H, et al. Clincal outcome of treatment with locking compression plate for distal femoral fracture in retrospective cohort. Journal of Orthopaedics Surgery and Research.2019; 14: 384(2019)