IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 16, Issue 2 Ver. V (February. 2017), PP 84-101
www.iosrjournals.org

Radiological And Functional Outcome of Closed Ankle Fractures Treated By open Reduction And Internal Fixation

Dr. Sandesh Reddy Yaratapalli[1],Dr. M.R. Thirunthaiyan[2],
Prof. R. Dorai Kumar[3]
[1(]*Department Of Orthopaedics, Sri Ramachandra University, India)*
[2(]*Department Of Orthopaedics, Sri Ramachandra University, India)*

Abstract: *To evaluate clinically and radiologicalliy the type of injury and to analyze the results of closedbimalleolar ankle fractures treated withopen reduction and internal fixation. This is prospective study done at Sri Ramachandra University, Chennai 2013to assess the functional and radiological outcome of closed bimalleolar ankle fractures treated by open reduction and internal fixation. The duration of study was 18 months with a minimum follow up of 3 months to a maximum of 18 months. (Avg-12 months). Total number of Patients assessed and evaluated in this study were 30. Patients were followed clinicallyand radiologically evaluated at 6 weeks, 12 weeks, 24 weeks and thereafter, every year. Post-Operative evaluation of function and radiological outcome was done using the Baird and Jackson scoring system. This score is based on the criteria ofpain, stability of ankle, ability to walk, run and do work, ankle movements and radiological analysis.Based on the Baird and Jackson scoring system, we graded our results as Excellent, Good, Fair and Poor. Our results wereExcellent in 9 Cases (30%), Good in 11 Cases (37%), Fair in 4 Cases (13%) and Poor in 6 Cases (20%). After open reduction, the medial malleolus was fixed using an implant based on type of fracture and the soft tissue condition. Maximum medial malleoli fixation was done using cancellous screws alone (57%) and tension band wiring (27%).After open reduction, the Lateral malleolus was fixed using an implant based on type of fracture and the soft tissue condition.Maximum lateral malleoli fracture fixations done using plate fixation (84%). Fewer cases were fixed with tension band wiring and K-Wire. One case was left unfixed and was immobilized using a below knee POP slab for 3 weeks.A syndesmotic screw was needed to stabilize the syndesmotic joint for 3 cases. Posterior malleolus needed operative fixation in 2 cases. All Patients were evaluated pre-operatively by clinical and radiologicalmethods. The Fracture patterns were classified by the mechanism of injury described by Lauge – Hansen. Our study showed a predominance of Supination – External Rotation injuries (33%) followed by Pronation - External Rotation (27%), Pronation – Abduction (23%) and 17% of supination – adduction injury. Immediate open Reduction and Internal Fixation in ankle fractures yield good results in terms of anatomical reduction, stability and Post Op functional return. Supination External Rotation injury is the commonest mechanism of injury in our study.Patient operated early, only if soft tissue was good,in order to have good functional outcome in closed ankle fractures. Delay in surgery tended to give a poorer result.Good control of comorbidities decreased Post Op complications.Early return of ankle movements Post OP with proper rehabilitation improved functional outcome[19].After a year of surgery, most patients experience little or mild pain and have certain restrictions of functional activities. Patients who needed syndesmotic joint operative stabilization, had poorer outcomes at the end of one year as compared to those that needed fixation of only bimalleolar fractures.*

Keywords*: Baird and Jackson scoring system, Lauge – Hansen Classification, Syndesmosis, Medial and Lateral Mallelous.*

I. Introduction

It is important to note that right from 300 BC starting from Hippocrates many a detailed account is available in the literature of ankle injuries. Sir Percival Pott (1714-1788),Tillauz (1872) (described fracture of anterolateral margin of tibia implicating the anterior syndesmotic ligaments), Baron Dupuytren, J.G. Maisonneuve have all greatly contributed to understanding of ankle injuries. However the problem of understanding ankle injuries remained unsolved till the advent of x rays by Konard Roentgen (1895). Cotton (1915) described malleolar fractures. In 1922 Ashurst and Bromer understood exact mechanism and classified ankle injuries. In 1950, Lauge Hansen based on cadaveric experiments, clinical and radiological findings derived a genetic classification. In 1972 Danis Weber classified the ankle injuries concentrating mainly over fracture of fibula, which is accepted by AO/ASIF group.

The ankle injuries gained importance because body weight is transmitted though it and the locomotion depends upon the stability of this joint. It must be realized that ankle injuries are mixed ones, ligamentous and body failures due to deforming forces, thus the primary goal of treatment should be full restoration of anatomy

and function of the ankle joint. Bohler in 1929 discussed the importance of accurate reduction and possible joint motion. Though malleolar fractures are discussed extensively, the opinions in the treatment of these fractures varies widely because of differences in classification reduction techniques and subjective symptoms at follow up studies. Many of these fractures were managed by manipulative reduction and conservative treatment and have yielded satisfactory results. Injuries like unstable syndesmotic diastasis, tri or bimalleolar fractures required open reduction and fixation.

II. Aim Of The Study

To evaluate clinically and radiologicalliy the type of injury and to analyze the results ofclosedbimalleolar ankle fractures treated withopen reduction and internal fixation.

III. Materials And Methods

This is prospective study done at Sri Ramachandra University, Chennai between April 2012- October 2013to assess the functional and radiological outcome of closed bimalleolar ankle fractures treated by open reduction and internal fixation. The duration of study was 18 months with a minimum follow up of 3 months to a maximum of 18 months. (Avg-12 months)
Total number of Patients assessed and evaluated in this study – 30

3.1: Method Of Selection

Inclusion Criteria

(i) Closed ankle fractures in adults
(ii) Associated with subluxation & dislocation of the ankle joint.

Exclusion Criteria

(i) Open fractures.
(ii) Talar fractures.
(iii) Associated fractures of ipsilateral limb.
(iv) Pilon fractures.
(v) Children below 18 yrs.
(vi) Pathological fractures.

All patients were evaluated pre-operatively by clinical examination of the fracture site andradiologically using the Lauge-Hansen classification.

3.2: Preoperative Protocol

Displaced, malleolar fractures often involve significant subluxation or dislocation of the tibiotalar joint. To minimize pain, swelling and local trauma, such injuries were treated initially with analgesics, closed reduction and immobilization using a below knee slab. This was followed by limb elevation using pillows to reduce swelling. Prompt closed reduction of the ankle mortise decreases articular damage and in turn decreases soft tissue swelling. Operative treatment wasusually delayed for a few days till the initial swelling had subsided.If soft tissue injury like abrasions and lacerations or blisters were present, surgery was delayed until the skin had healed. This was to minimize risk of infection post operatively. Patients were operated immediately only if the patient presented immediately after injury and if skin over fracture site was healthy, provided general condition of the patient was stable.

3.3: Operative Protocol

All Patients were operated under spinal or general anesthesia in a supine position with tourniquet control and using image intensifier. The implants used were3,5 mm reconstruction plate, one third tubular plate,kirschner wire, 3.5 mm DCP, LCP and tension band wiring for the fibula. Tension band wiring, locked compression plates and 4mm partially threaded cancellous screws were used for the medicalmalleolus. And for the posterior malleolus, a 4 mm cannulatedpartially threaded cancellous screwwith or without washer was used. A single 3.5 mm cortical screw was used in fixing of syndesmotic joint. Implants were selected based on the fracture pattern, quality of the bone and surrounding soft tissue.

3.4: Choice And Planning Of Fixation

A satisfactory fixation technique must have a low risk of failure, must resist the forces that are likely to causes re-displacement of the fracture and must not increase comminution or cause displacement during its application.

Lateral Malleolus

Weber Type A: The fracture is reduced, held with a reduction forceps and stabilized either by tension band wiring or a lag screw.

Weber type B: After reduction, the fracture is fixed with one or two lag screws placed perpendicular to the line of fracture. More commonly a plate is used to neutralize the rotational and axial forces on the fibula. One-third tubular plate conforms to the curvature of the fibula and has a lower profile than the thicker DCP. The fibular plate can also be placed posteriorly as an antiglide plate to resist posterior migration and rotation of the distal fragment.

Weber type C: Transverse fibular fractures are reduced and fixed with a one-third tubular plate, Reconstruction plate or narrow 3.5 mm DCP to resist migration and rotation of the distal fragment.

Anatomic reduction of the fibula will usually restore the mortise and additional fixation of the syndesmosis may not be needed, especially if the fibular fracture is within 3 to 4 cm of the joint. Fractures of the proximal fibula need not be internally fixed.

Medial Malleolus: Avulsion fractures of the medial malleolus are reduced and fixed with either a tension band technique or cancellous screws. A fracture above the deltoid attachment is reduced and provisionally stabilized with K wires placed perpendicular to the fracture. Each wire is then removed and replaced with a 4mm partially threaded cancellous screw. Two points of fixation are needed to control rotation of the medial malleolar fragment and either two screws or a combination of a screw and a K-wire are used.

Posterior Malleolus: Open reduction and internal fixation has generally been recommended when more than 25% of the posterior articular surface is involved or the fracture is displaced more than 2mm. The decision to fix the posterior fragment is based on the amount of residual displacement after reduction of the fibula. A partially threaded 4 mmcannulatedcancellous screw with or without washer is used by with anterior or posterior approach.

Anterior Malleolus: Indications for operative treatment are the same as that for posterior malleolus Lag screws alone are usually sufficient for fixation, but a buttress plate may be needed if the fragment extends into the distal shaft of the tibia.

Syndesmotic Injury: yndesmotic stability is checked by laterally displacing the fixed distal fibula from the tibia while observing the relationship of the two bones. If more than 2 to 4 mm of lateral shift of the talus occurs then instability is present. More recent studies have shown that anatomic reduction of the fibula, especially if the fracture is within 4 mm of the joint, usually reduces the talus in the mortise and restores stability to the syndesmosis. Intraoperatively, syndesmotic instability can be assessed by the Cotton test.

The syndesmotic screw is used to hold, but, not compress the syndesmosis. Because the fibula is posterior to the tibia the syndesmotic screw is angled from posterolateral to anteromedial in order to engage the tibia. The foot is placed in dorsiflexion to bring the widest portion of the talus into the mortise. This screw in placed just above the level of the tibiofibular ligament with 3 cortex purchase.

3.5: Wound Closure And Post-Operative Care

The wounds were irrigated and closed, deeper structures with absorbable suture material and superficial layers with interrupted non-absorbable skin sutures or skin staples. Generally a well-paddeddressing with crepe bandage was used to reduce hematoma formation with limb elevation with 2 pillows till the sutures were removed. In case of K-Wire fixation of a malleolus or if a malleolus was left without fixation, a well-padded below knee POP was applied for 3 weeks. Range of motion, strengthening andmobilization exercise were included in the rehabilitation program. Sterile dressings were done at POD 2, 5, 9 and 12, with suture removal at POD 12, depending on surgical wound and soft tissue condition. After six weeks progressive unrestricted weight bearing was allowed.

3.6: Post – Operative Protocol

- I V antibiotics for 3 days.
- This was followed with oral antibiotics till suture removal.
- 1st wound inspection on second post- operative day.
- Check x-ray taken.
- Suture removal on 12th day.
- Non – Weight bearing mobilization started from 3rd post-operative dayand active ankle mobilization exercises started.
- Non – Weight bearing mobilization continued for 6 weeks.
- Partial weight bearing after 6 weeks till 12 weeks, depending on fracture pattern and comorbidities.
- Full weight bearing walking started after 8 or 12 weeks, depending on fracture pattern, fixation and patient tolerance.
- Patient with syndesmotic injuries were generally kept non-weight bearing for 6 to 8 weeks.

- Syndesmotic screws were not removed before the start of weight bearing.

3.7: Post – Operative Evaluation

Atients were followed clinically and radiologically evaluated at 6 weeks. 12 weeks, 24 weeks and thereafter, every year. Post-Operative evaluation of function and radiological outcome was done using **the Baird and Jackson scoring system**. This score is based on the criteria ofpain, stability of ankle, ability to walk, run and do work, ankle movements and radiological analysis.

Scores according to the Baird and Jackson scoring system

1. Excellent 96 - 100
2. Good 91 – 95
3. Fair 81 – 90
4. Poor 0 – 80

Maximum possible score – 100

IV. Results

Based on the Baird and Jackson scoring system, we graded our results as Excellent, Good, Fair and Poor. Our results were,

Excellent - 9 Cases (30%)
Good - 11 Cases (37%)
Fair - 4 Cases (13%)
Poor - 6 Cases (20%)

This study shows a male predominance of 64% (19) over a female pecentage of 36(11). In our study, the mean age group falls in the middle age (43yrs), with more number of patients between 30 and 50 yrs of age. In our study, there is a right sided predominance of the fracture. Our study shows that slip and fall, accounting to 53% of the total number of cases, is the most common cause for injury, followed by road traffic accidents. In our study, Supination External Rotation (SER) mode of injury is the commonest fracture pattern with 33% of total cases and Supination Adduction as the rarer presentation in 17% of the cases.Most of the cases in this study presented to the hospital almost immediately following trauma, accounting to 83%, with 10% of the cases presenting late. In our study, there is a delay of 2 – 7 days for surgical treatment for most cases. Depending on various criteria like patients general condition, comorbidities, soft tissue condition at fracture site, etc. surgery was done within 48 hours of trauma or delayed. This clearly showed that when surgery was done within the first week following trauma, patients had a superior end functional and radiological result when compared with patients who were operated after 1 week. Maximum medial malleoli fixations done using cancellous screws alone (57%) and tension band wiring (27%). Maximum lateral malleoli fracture fixations done using plate fixation (84%). Fewer cases were fixed with tension band wiring and K-Wire. One case was left unfixed and was immobilized using a below knee POP slab for 3 weeks. A syndesmotic screw was needed to stabilize the syndesmotic joint for 3 cases. Posterior malleolus needed operative fixation in 2 cases. Eight patients of 30 had comorbidities, and 50% of that 8 had complications. Of the 22 patients without any known comorbidities, only 2 developed complications, accounting for only 9% of the cases without comorbidities.

Complications

We had our fair share of complications with 1 case of infection, 2 cases ofmalunion, 1 nonunion, 1 case with delayed union and 1 case with wound dehiscence with infection.

VII: Tables

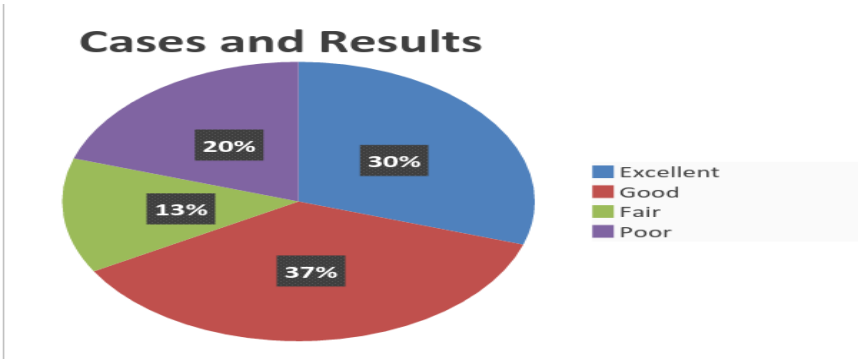


Table 1: showing the results

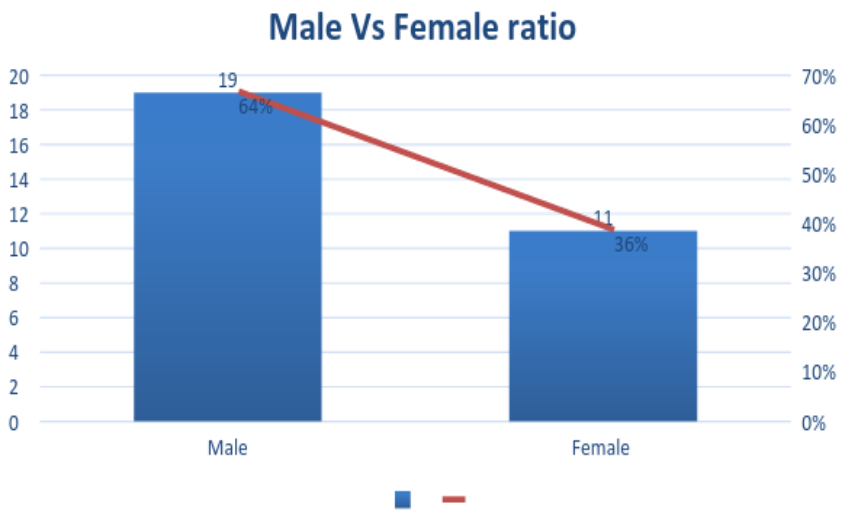


Table 2: showing the ratio of male and female population

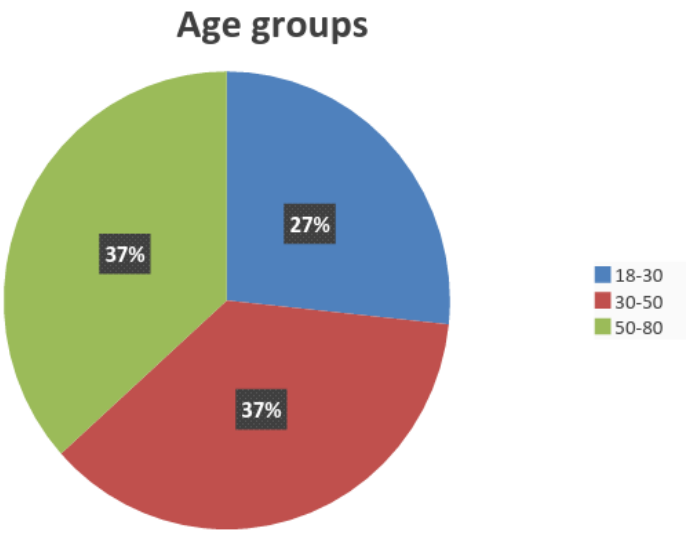


Table 3: showing the age distribution

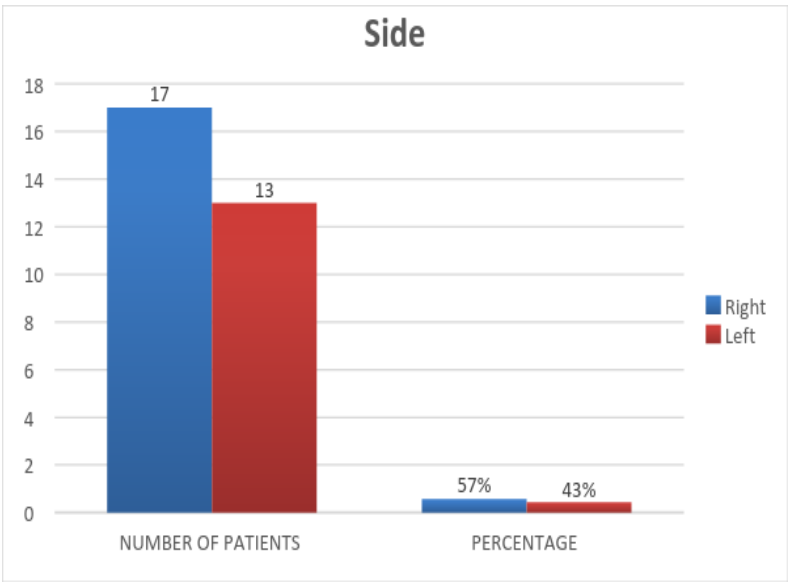


Table 4: showing the percentage of side involved

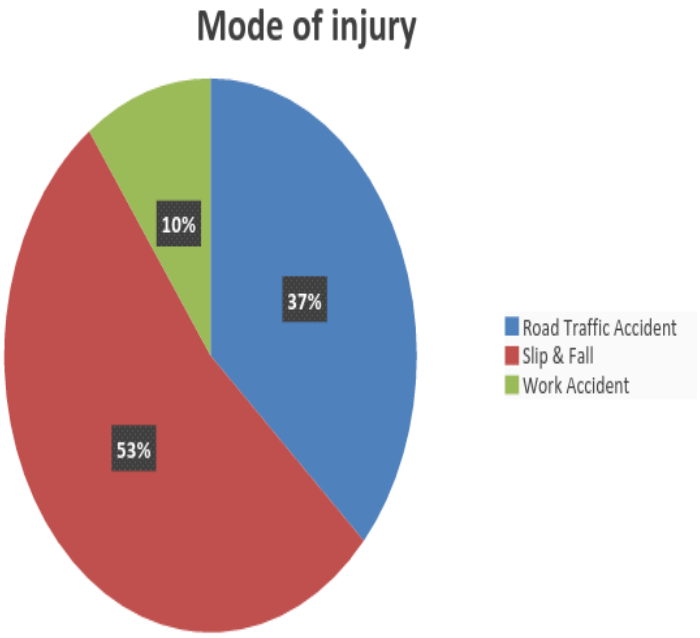


Table 5: showing the percentage of various modes of injury

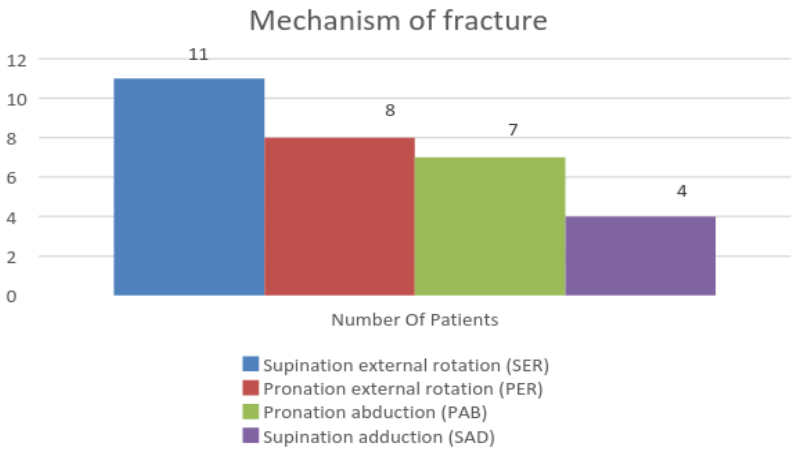


Table 6: showing the mechanism of injury

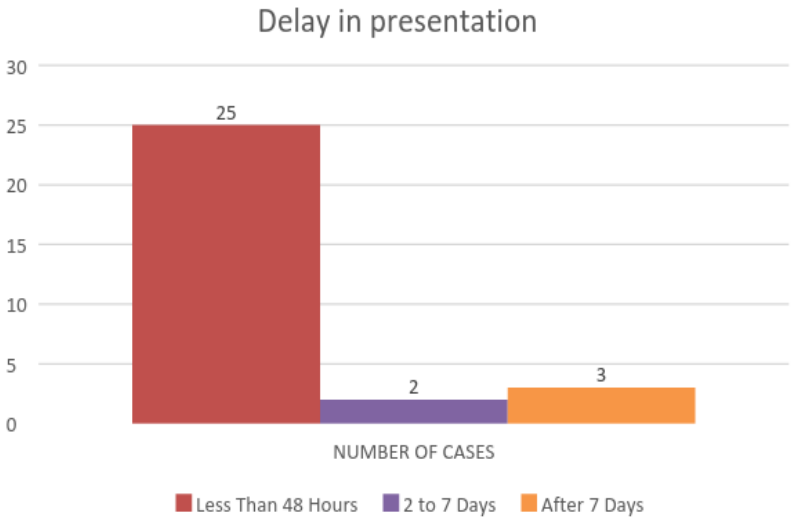


Table 7: showing the delay in presentation from the time of injury

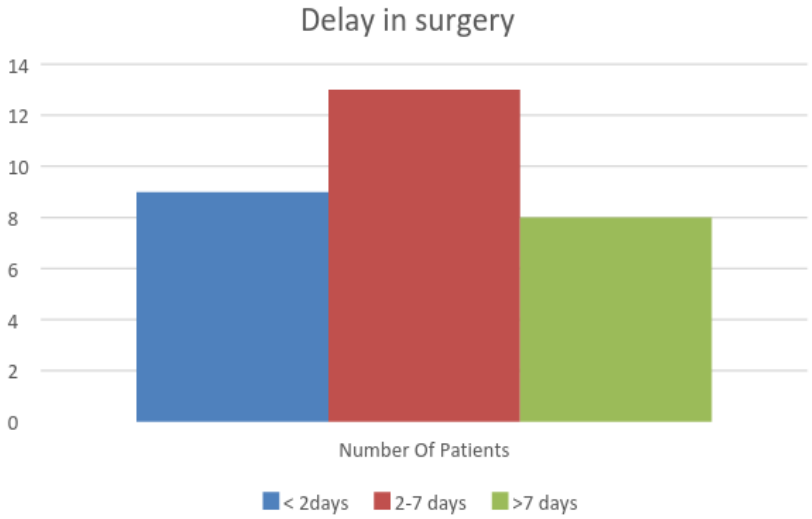


Table 8: showing the time from presentation to the time of surgery

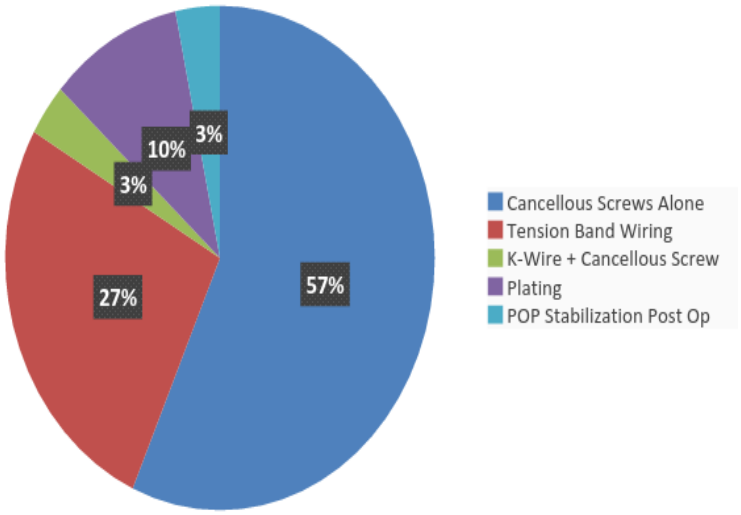


Table 9: showing the various methods used for medial malleolar fixation

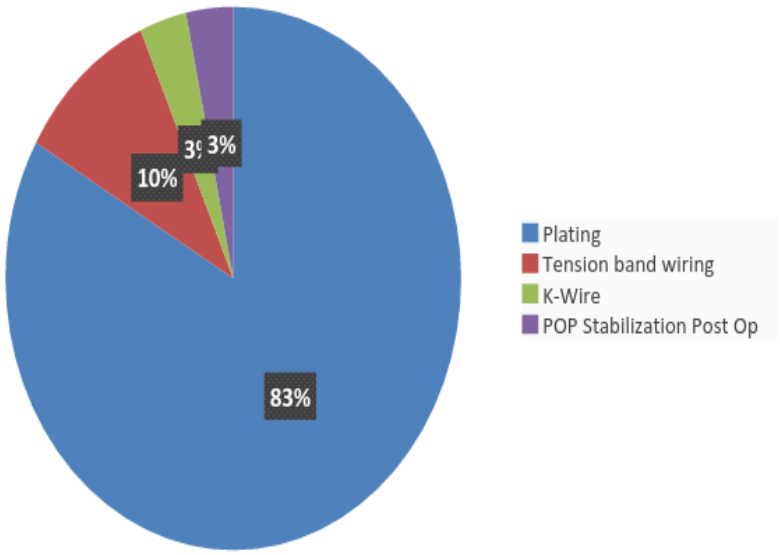


Table 10: showing the methods of lateral malleolar fixation

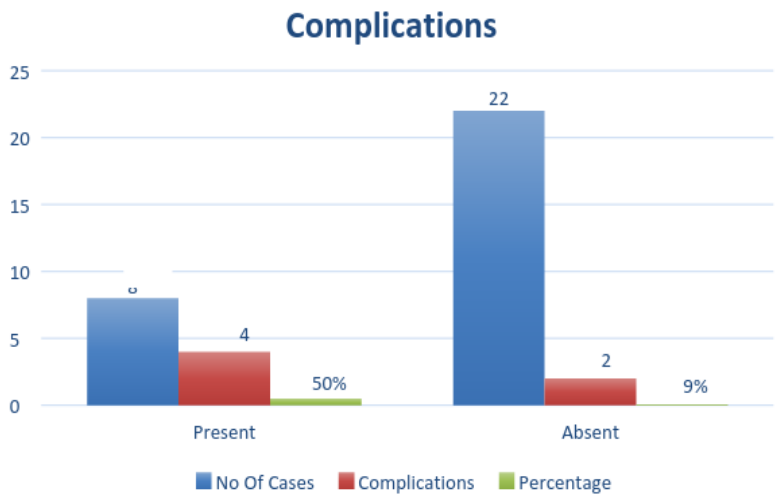


Table 11: showing the percentage of post-op complications

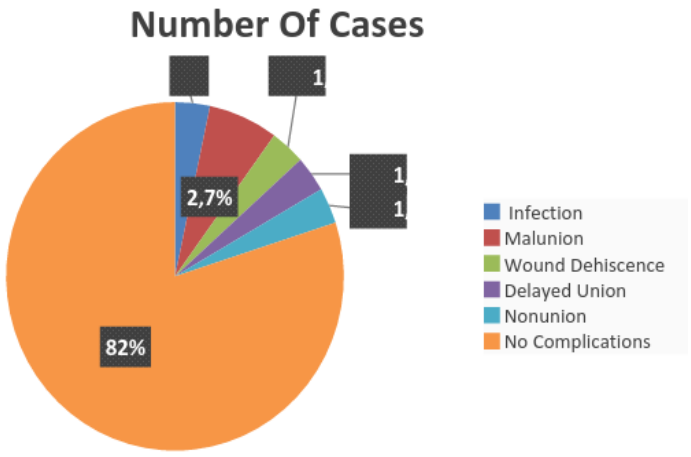


Table 12: showing various complications post-op

VII: figures

Case: 1
Type - Supination External Rotation FractureBaird And Jackson Score - 91
ROM – Dorsiflexion - 25 Degrees Result - Good
Plantar Flexion - 45 degrees Duration Btw Trauma AndSurgery- 3 Days
Comorbidities - None

Pre OP **Post OP**

6 Months post op

1 year post op

Neutral position

Bilateral Plantar Flexion

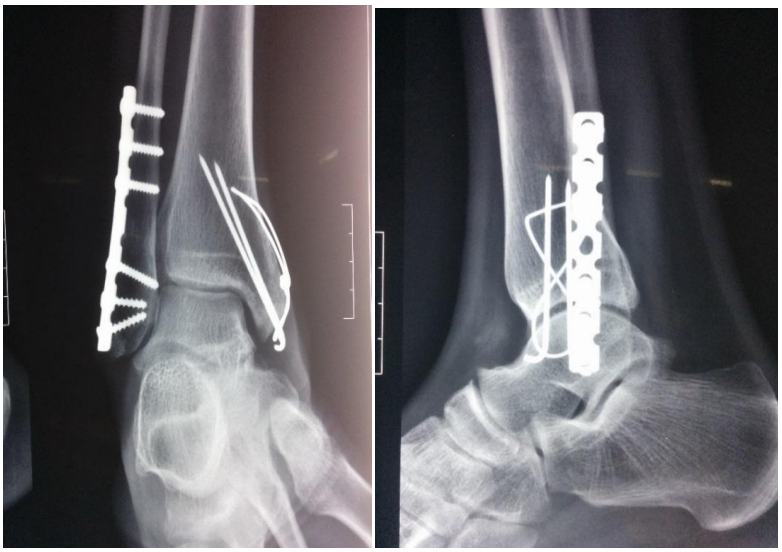
Bilateral Dorsiflexion

Standing

Case: 2
Type– Supination External RotationBaird AndJackson Score - 97
ROM – Dorsiflexion - 25 DegreesResult - Excellent
Plantar Flexion - 45 DegreesDuration Btw Trauma And Surgery – 3 Days
Comorbidities - None

Pre OP **Post Op**

6 Months Post Op



1 Year Post Op

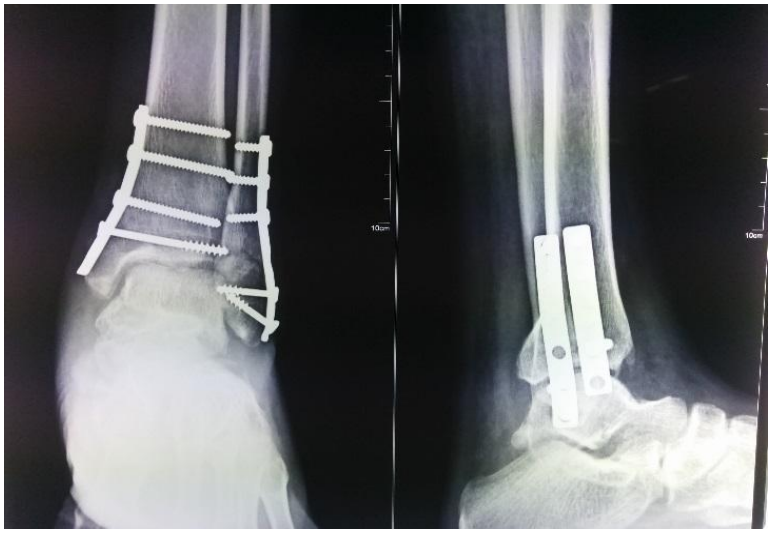
Feet In Neutral Position

Bilateral Feet on Plantar flexionBilateral feet on dorsiflexion

Case: 3

Type - Supination Adduction Baird And Jackson Score - 100
ROM – Dorsiflexion -30 Degrees Result - Excellent
Plantar Flexion - 40 DegreesDuration Btw Trauma And Surgery–1 Day
Comorbidities - None

Pre Op **Post Op**



6 Month Post Op **1 Year Post Op**

2 year follow up

Neutral Position

Bilateral Dorsiflexion

Bilateral Plantar Flexion

Daily living activities

Case: 4
Type –Pronation AbductionBaird And Jackson Score - 77
ROM – Dorsiflexion - 20 Degrees Result - Fair
Plantar Flexion -40 Degrees Duration Btw Trauma And Surgery - 11 Days
Comorbidities - CAD, COPD, DM

Pre OP Post Op

3 Months Post Op

6 Months Post Op

1 Year Post Op

Feet In Neutral

Surgery Site

Bilateral Dorsiflexion

Bilateral Plantar Flexion

V. Complications

We had 6 cases with complications which were followed up. Wound infection was seen in one case (3%), malunion in one case (6%), wound dehiscence in one case (3%) with 3% delayed union and 3% nonunionin this study, and this is related to the presence of comorbid conditions like diabetes mellitus,

hypertension, etc. The study shows that there is a direct relationship between comorbidities and final scores in patients. Around 50% of the cases with comorbid conditions developed complications, whereas only 9% of the cases without any comorbidities developed complications. All cases with complications, developed a poor result. This is similar to the results of Costigan et al. and Jones et al., who identified neuropathy and hypertension as the most important predictors of postoperative complications in diabetic patients with ankle fractures[14].

The study had a malunion ratio of 6%, which shows that soft tissue condition at time of surgery, and delay in surgery result in poorer results.Fogel et al. showed a higher rate of malreduction when surgical delay exceeded 1 week for ankle fractures[22].

X: Conclusions

Immediate open Reduction and Internal Fixation in ankle fractures yield good results in terms of anatomical reduction, stability and Post Op functional return.Supination External Rotation injury is the commonest mechanism of injury in our study. Patient operated early, only if soft tissue was good, in order to have good functional outcome in closed ankle fractures. Delay in surgery tended to give a poorer result. Good control of comorbidities decreased Post Op complications. Early return of ankle movements Post OP with proper rehabilitation improved functional outcome. After a year of surgery, most patients experience little or mild pain and have certain restrictions of functional activities. Patients who needed syndesmotic joint operative stabilization, had poor outcomes at the end of one year as compared to those that needed fixation of only bimalleolar fractures.

References

[1]. Ahl T. Dalen N, Holmberg S Et Al. Early weight bearing.
[2]. Andrei Homa Et Al. Functional outcomes of Closed Ankle Fractures. Journal Orthop Trauma. Vol. 106, 189-194 1984.
[3]. Beauchamp Cg, Clay Nr, Thexton Pw: Displaced Ankle fractures in Patients over 50 years of age. JBJS 65b: 329, 1983.
[4]. Bauer M. Bergstrom B, Hemborg A, Et Al. MalleolarFractues: Non – Operative versus operative treatment. A controlled study. Clin. OrthopRelat Res. 1985: 17-27.
[5]. Beris AE, Kabbani KT, Xenakis TA, et al. Surgical treatment of malleolar fractures. A review of 144 patients. ClinOrthopRelat Res 1997:90-98.
[6]. Blotter RH, Connolly E, Wagan A, Chapman Mw. Actue complications in the operative treatment of isolated ankle fractures in patients with DM. Foot Ankle. Int. 20: 687, 1999.
[7]. Bostman. OM, Ankle fractures treated using biodegradable int. fixation. Clin. Orthop – 238: 195, 1989.
[8]. Breederveld. Rs. Van Straaten. Immediate (or) Delayed operative treatment of fractures of the ankle. Injury 19: 436: 1988.
[9]. Brodie. Iaod ; Denham RA. Treatment of unstable ankle fractures. JBJS 56 B: 256, 1974.
[10]. Campbell Operative Orthopaedics.
[11]. Carragee EJ, Csongradi JJ, Bleck EE. Early complications in the operative treatment of ankle fractures. Influence of delay before operation. J Bone Joint Surg Br 1991;73B: 79-82.
[12]. Christian J.P. Simanski, Rolf. Lefering, Thomas Tiling et al. Functional treatment and early weight bearing after an ankle fracture. J. Orthop. Trauma. 2006; 20: 108-114.
[13]. Colton C.L.: Watson - Jones fracture and joint injuries, Vol. II, 6th Edition, 1104 -1152,1992.
[14]. Costigan W, Thordarson DB, Debnath UK. Operative management of ankle fractures in patients with diabetes mellitus. Foot Ankle Int 2007;28:32-37.
[15]. Day GA, Swanson CE, Hulcombe BG. Operative treatment of ankle fractures: a minimum ten-year follow-up. Foot Ankle Int 2001;22:102-106.
[16]. Denham R.A. : Internal fixation for stable Ankle fracture JBJS. 46B : 206 -211, 1964.
[17]. Denis R. : The aims of Internal fixation Clin. Orthop, 138, 23-25, 1979
[18]. Egol KA, Amirtharajah M, Tejwani NC, et al. Ankle stress test for predicting the need for surgical fixation of isolated fibular fractures. J Bone Joint Surg Am 2004;86A: 2393-2398
[19]. Egol KA, Dolan R, Koval KJ. Functional outcome of surgery for fractures of the ankle. JBJS. Br. 2000; 82: 246-249.
[20]. Finnan R, Funk L, Pinzur MS, et al. Health related quality of life in patients with supination-external rotation stage IV ankle fractures. Foot Ankle Int 2005;26: 1038-1041.
[21]. Fracture and dislocation compendium. Orthopaedic Trauma Association Committee for Coding and Classification. J Orthop Trauma 1996;10(suppl 1):v-ix, 1-154.
[22]. Fogel GR, Morrey BF. Delayed open reduction and fixation of ankle fractures. ClinOrthopRelat Res 1987:187-195.
[23]. Gallent S, Frieberg T, Listeal P, Operative treatment in Ankle fractures Clini orthop16:118-124, 1983.
[24]. Gray's Anatomy, 555 : 1979.
[25]. Harper MC. Ankle fracture classification system. Foot Ankle 1992; 13; 404-407.
[26]. Henry Hollinshed. W Anatomy for surgeons Vol, 3, 822 ; 1969.
[27]. Hughes JL, Weber H, Willenegger. Evaluation of ankle fractures. non – operative & operative Trt. Clin. Orthop 138: 111, 1979.
[28]. James D. Michelson, Donna Magid. Clinical utility of a stability based ankle fracture classification system. J. Orthop Trauma. 2007, 21; 307 – 315.
[29]. Jones KB, Maiers-Yelden KA, Marsh JL, et al. Ankle fractures in patients with diabetes mellitus. J Bone Joint Surg Br 2005;87B:489-495.
[30]. Joy G, Patzakis MJ, Harvey JP Jr. Precise evaluation of the reduction of severe ankle fractures. J Bone Joint Surg Am 1974;56A:979-993.
[31]. Konvath G. Karges D. Watson JT et al. Early versus delayed treatement of severe ankle fractures. J. Ortho Trauma. 9 : 377, 1995.
[32]. Kornad, Gerhard et al. Tourniquets may increase post-operative swelling and pain after internal fixation of ankle fractures. CORR 433: 189- 194, April 2005.
[33]. Kristensen KD. Hansen T: Closed treatment of ankle fractures, stage II supination – eversion fractures. ActaOrthopScand 56: 107,

1985.
[34]. Lambert, K.C: The weight bearing function of the fibula, JRIS, 53A, 507,1971.
[35]. Lauge – Hansen N: Fractures of the ankle combined experimental surgical & Experimental – Roentgnologic investigations. Arch. Surg 60: 957, 1950;60:957-85
[36]. Lindsjo U.L.F. Operative treatment of ankle fracture dislocation clinorthop. 199 28:1985.
[37]. Limbird R.S. : Laterally comminuted fracture dislocation of ankle. JBJS 69 A/6, 881, 1987.
[38]. Lira RJM, Hernandez RL. Surgical treatment early versus delayed in ankle fractures and the cost implicatioins, ActaOrtopMex 2003: 17 (4) 188 – 191.
[39]. Manjoo, Ajay; Sanders, David W; Tieszer, Christina; MacLeod, Mark D
[40]. Journal of Orthopaedic Trauma. 24(1):2-6, January 201
[41]. McCormarck. RG, Leith JM. Ankle fractures in diabetes. Complications of surgical management JBJS 80 B: 689, 1998.
[42]. Michelson JD. Helgemo SL, AHN. UM: Dynamic biomechanics of the normal and fractured ankle. Trans Orthop Res Soc 40: 253, 1994.
[43]. Michelson JD, Fractures about the ankle. JBJS Am 1995; 77: 142-152.
[44]. Michelson JD, Varner KE, Checcone M. Diagnosing deltoid injury in ankle fractures: the gravity stress view. ClinOrthopRelat Res 2001:178-182.
[45]. Mont Miller et al. Post – operative radiographys as predictors of clinical outcome in unstable ankle fractures. J. Orthop. Trauma. 6:352-357, 1992.
[46]. Moore Jr JA, Shank JR, Morgan SJ, et al. Syndesmosis fixation: a comparison of three and four cortices of screw fixation without hardware removal. Foot Ankle Int 2006;27:567—72.
[47]. Muller M.E.Allgower E: Manual of internal fixation Berlin: Springer – Verlag : 282 1970.
[48]. Muller M. Comprehensive Classification of Fractures. In Bern M, ed. New York: Muller Foundation, 1996.
[49]. Pankovich AM. Trauma to the ankle. In MH Jhass, ed. Disorders of the Foot and Ankle: Medical and Surgical Management. 2nd ed. Philadelphia: WB Saunders, 1991: 2361-2414.
[50]. PankovichAM,Shivaram MS. Anatomical basis of variability in injuries of the medial malleolus and the deltoid ligament. I. Anatomical studies. ActaOrthopScand 1979; 50:217-223.
[51]. PankovichAM,Shivaram MS. Anatomical basis of variability in injuries of the medial malleolus and the deltoid ligament. II. Clinical studies. ActaOrthopScand 1979;50: 225-336.
[52]. Petrone, F.A. Gail, et al. Quantitative criteria for prediction of the results after displaced fracture of the ankle. JJS (Am) 65:66-77, 1983.
[53]. Phillips, Keller et al. A prospective, randomized study of the management of server fractures. JBJS (Am) 67 : 67-78, 1985.
[54]. Ramsey P.L, : changes in tibifibular area of contact caused by lateral talarshif JBJS, Vol, 58, A/3, 356 : 1979.
[55]. Reudi P. Thomas and Martin Allgower. The operative treatment of intra-articular fractures of the lower and of the tipiaclini-orthop, 138, 105, 1979.
[56]. Roberts Rs: Surgical treatment of displaced ankle fractures. ClinOrthop 172: 164, 1983.
[57]. Rowley, D.I. Norris & Duckworth. A prospective trial comparing operative & Manipulative treatment of ankle fractures. JBJS (Br) 68: 610 – 613, 1986.
[58]. Scheidt KB, Stiehl JB, Skrade DA, et al. Posterior malleolar ankle fractures: an in vitro biomechanical analysis of stability in the loaded and unloaded states. J Orthop Trauma 1992;6:96-101.
[59]. Sarkisian JS, Cody Sw. Closed treatment of ankle fractures. J. Trauma. 16: 323, 1976.
[60]. Tuntuir, K. Patiala, Rokkanen. Importance of anatomical reduction for subjective recovery of ankle fracture. Actaorthop Scand. 54: 641-647, 1983.
[61]. Van Laarhoven. CJ, Meeuwis JD, Van Der. W. Post – operative treatment of internally fixed ankle fractures. A prospective randomized study. JBJS Br 1996; 78: 395-399.
[62]. Watson – Jones Fracture and joint injuries. Volume II 6 Edition Pg. 1104-1152 1992.
[63]. Wheelhouse WW, Rosenthal RE. Unstable ankle fractures. South Med.J. 1980: 73: 45-50.
[64]. William B. Geissler, Audrev K. Tsao and James L. Hughes; Rock Wood and Green; Fractures in aduits Vol. II 4th 2201-2266 Edition
[65]. Wilson FC: The pathogenesis & treatment of ankle fractures: Historical Studies. Instr. Course Lect. 39: 73, 1990.