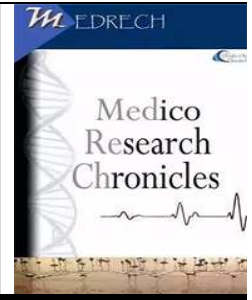




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Prospective Study of Radiological Healing and Functional Outcome After Open Reduction and Internal Fixation of Danis-Weber Type-C Closed Ankle Fracture

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ABSTRACT

Background: Ankle fractures are one of the most widespread lower limb fractures in adult, account for 9% of all fractures; one fourth constitutes bimalleolar fractures. As they remain a significant source of morbidity for both the young and the elderly, so proper fixation of fracture is required for a healthy outcome. **Objective:** To assess radiological healing and functional activities of treatment of Danis-Weber type-closed ankle fracture. **Methods:** A prospective observational study was carried out in Monno Medical College and Hospital, Manikganj, from June 2022 to December 2022. A total of 28 patients with Danis-Weber type-C ankle fracture were taken in this study. All the patients were initially managed by analgesic and short leg posterior slab. After admission, all were treated by ORIF with small DCP for fibula fracture and ORIF by two 4mm cannulated cancellous screws for medial malleolus fracture. Operations were done within 4 days to 14 days. The average follows up was 24 weeks. The outcome was assessed by the AOFAS score. **Results:** Out of 28 patients 14(50%) were 18 to 30 years of age, 7 (25%) were 31 to 40 years old, 5 (18 %) were 41 to 50 years old and 2 (7.1%) were 51-60 years old. The mean age was 34.68 ± 10.79 years. Majority 20 (71%) of the patients were male and the rest 8 (29%) were female. 18 (64.3%) patients presented with right sided ankle fracture and 10 (35.7) with left sided fractures. Vast majority, 19 (68%) of injuries, were caused by RTA, 7 (25%) were twisting fall, 1 (3.6%) was fall from height and another 1(3.6%) was due to physical assault. 7(25%) patients surgery was done within 1st week, 21(75%) patients done in 2nd week from the occurrence of injury. Among 16(57.1%) patients had radiological evidence of healing

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at 12 weeks, 10(35.7%) had healing evidence at 14 weeks and in 2(7.1%) patients it was at 16 weeks. Mean duration of appearing radiological healing was 13.34 ± 1.56 weeks range 12-16 weeks. 27(96.4%) patients had no limitation on daily activities, but had limitation on recreational activities. Our 11(39.3%) patients stayed 3 weeks and 16(57.1%) patients stayed 2 weeks. Mean duration of hospital stay was 14 ± 2.68 days with minimum of 7 days and maximum of 17 days. In this study, out of 28 patients, final outcome was satisfactory (Excellent 13 and Good 11) in 24 (85.7%) cases and Unsatisfactory (fair 4 and poor 0) in 4 (14.3%) cases according to American Orthopedic Foot and Ankle Score. **Conclusions:** The study shows that proper operative treatment of Danis-Weber type C ankle fracture by the selected implant leads to excellent to good radiological and functional results with uncomplicated recovery in the majority of the cases. Appropriate patient counselling is necessary to prepare patient ready for the expected functional outcome.

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INTRODUCTION

Ankle fractures are one of the most common lower limb fractures. The annual incidence of an ankle fracture is between 107 and 184 per 100,000 persons. They account for 9% of all fractures; one fourth constitutes bimalleolar fractures [1]. Ankle fractures have an incidence of 122/100,000 per year, making them the fifth most common fracture [2]. Ankle fractures are among the most common osseous injuries to the lower extremity and remain a significant source of morbidity for both the young and the elderly [3]. Ankle fractures are common injuries presenting to trauma departments and open reduction and internal fixation (ORIF) is one of the first procedures targeted in early orthopedic training [2]. The most common causes of ankle fractures are twisting injuries and falls, followed by sports injuries. However, in the subcontinent scenario, road traffic accidents are the most common mode of injury [4]. Surgical reduction and internal fixation is the mainstay for the treatment of the unstable ankle fractures. There are various surgical modalities include fixation with cancellous lag screws, malleolar screw, tension band wiring for medial malleolus and semi-tubular plate,

one-third tubular plate, fixation with a rush pin, fixation with small DCP for lateral malleolus. Ankle fractures are one of the most common lower limb fractures; they account for 9% of all fractures, representing a significant proportion of workload [4]. Approximately 2% of the general population will sustain an ankle fracture during their lifetime [5]. Fracture of the ankle is the most common fracture involving joints. Being a weight bearing joint, maximum thrust passes through it and obviously it is subjected to many different types of injury. Testimony to this is the past and many of which are still in use. Disability following ankle fracture may result in the serious sequel like osteoarthritis, infection etc. Slight variation from a normal alignment of joint is incompatible with proper function. Therefore, it is essential to obtain anatomic reduction and stability following such fracture. It is very important in all the ankle fractures that a definitive diagnosis is made based on clinical evaluation of history, mechanism of injury, degree of immediate disability and obtaining proper radiograph to demonstrate lesion [6]. Most of the fractures are associated with ligament injuries, and the magnitude and the direction of the deforming

force applied to the ankle joint directly correlate to the fracture pattern [4]. Ankle fractures involving the fibula above the distal tibiofibular syndesmosis usually indicate an injury of the syndesmosis up to the level of the fracture. External rotation injuries usually result in anterior tibiofibular diastasis where the disruption proceeds from anterior to posterior. On the other hand, in total tibiofibular diastasis, the disruption proceeds from distal to proximal and can result from either abduction or external rotation injury [7]. There are various methods of operative treatment in ankle fractures such as screw, tension operative bands, semi-tubular plate, locking plate or external fixation. These techniques aim to provide anatomical restoration and immediate stability, which facilitates earlier mobilization [4]. The outcome also differs in a different type of implant use in Danis-Weber type C ankle fracture fixation. Traditional sub periosteal plating techniques strip the remaining soft tissue from the fracture, making the fragments extremely difficult to align and stabilize with a lateral plate, which has led to recommending bone graft for comminuted fractures. Extra periosteal plating by bridging techniques with small locking DCP preserves the periosteum and indirectly reduce comminution, have been used for the treatment of other long bones [8]. Small DCP for lateral malleolus and 4 mm partial threaded cancellous screw for medial malleolus is one of the important implants used by a different surgeon. However, there is no published data regarding this implant among the Bangladeshi population. The present study has been designed to see the functional and radiological outcome of fibula fixation by small DCP and medial malleolus by 4mm partial threaded cancellous screw in Danis-Weber Type-C ankle fracture in adults.

MATERIALS AND METHODS

Study design: A prospective observational study.

Period of study: June 2022 to December 2022.

Place of study: Monno Medical College and Hospital, Manikganj, Bangladesh.

Study population: Clinically and radiologically diagnosed admitted patients with closed Danis-Weber type C ankle fracture in orthopedic department of Monno Medical College and Hospital, Manikganj, Bangladesh.

Sample size: 28 patients were included for evaluation.

Inclusion criteria

- Patients with age between 18 to 60 years.
- Patients with closed Danis-Weber Type-C ankle fracture
- Injury of less than 3 weeks.
- All sexes.
- Both sides.

Exclusion criteria

- Previous fracture in the same limb.
- Open fracture.
- Patients with closed Danis-Weber type-A, B ankle fracture.
- Associated fractures around ankle joint other than medial malleolus.
- Medically unfit cases e.g. uncontrolled DM, CRF, COPD etc. (ASA score >4).
- Those who are not willing for surgery.

Data Management: Data collection Instrument: The data collected in a prescribed data collection sheet with a pre-tested structured questionnaire containing patient's hospital profile, injury profile, and operation profile, management after operation, complication, rehabilitation and follow-up.

Data Collection Procedure: Cases were selected from orthopedic department of Monno Medical College and Hospital, Manikganj having closed Danis-Weber type C ankle fracture. After counselling for surgery, an informed written consent was taken for operation and anesthesia after proper pre-operative check-up. Operations were done in Monno Medical College and Hospital by different surgeons. Pre-operative, per-

operative and post-operative data were recorded. Each patient was followed up for 24 weeks for radiological and functional evaluation and limited physiotherapy was given. Final radiological and functional outcome was evaluated by AOFAS score and was recorded.

Study procedure: After selecting case according to inclusion and exclusion criteria, patients were evaluated pre-operatively. After preparing the patients, operation was done. Injection Ceftriaxone and Flucloxacillin were given per-operatively followed by oral Cefixime and Flucloxacillin for 14 days. Patients were discharged from hospital at 2nd POD. 1st follow up was given at 14th POD to check any signs of infection, pain status and distal neurovascular status, stitches were removed on the same day. X-ray was done. Next follow up was taken 6 weeks after operation. Range of motion was tested and repeat X-ray was done. Improvement was noted. Subsequent follow up was given at 9th, 12th, and 24th week after operation. At last follow up, X-ray was done and final assessment was done according to AOFAS.

Operative procedure: Open reduction and internal fixation was by small dynamic compression plate (small DCP) and two 4mm partial threaded cannulated cancellous screws.

RESULTS

Table-I: Age of the study subjects (N=28)

Age (years)	Frequency	Percentage(%)
18-30	14	50
31-40	7	25
41-50	5	17.9
51-60	2	7.1
Total	28	100.0
Mean± SD		34.68±10.79
Range		22-60

Total number of 28 cases with Danis-Weber Type-C ankle fracture who full-filled the inclusion criteria were selected. Most of the patients were followed up for 24 weeks. Table 1 demonstrates that out of 28 patients

Advice on discharge: Patients were discharged with advice of quadriceps exercise, active movement of knee and ankle. Patients were advised not to bear weight for 8 weeks.

Follow Up: All patients were intended to be followed up for 48 weeks. But at least 24 weeks follow up was given in all cases. Each patient was evaluated clinically, radiologically and functionally.

Clinical: Total active range of movement of ankle joint was determined. Any complication was noted during follow up. Partial weight bearing was started after 8 weeks and full weight bearing was started after 12 weeks of operation.

Radiological: Radiographs were taken at each visit. During each visit, counselling of the patient about role of physiotherapy, psychological support and rehabilitation were given.

Statistical Analysis: Analysis done by SPSS 22 for windows software. The data tabulated and quantitative parameters such as age of patient summarized in terms of mean with standard deviation, to understand the variation present in the data. Percentage expression for positivity of scoring estimated along with 95% confidence interval. The significance of the results as determined in 95% confidence interval and a value of $p < 0.05$ considered to be statistically significant.

14(50%) were 18 to 30 years of age, 7 (25%) were 31 to 40 years old, 5 (18%) were 41 to 50 years old and 2 (7.1%) were 51-60 years old. The mean age was 34.68± 10.79 years, the

youngest of which was 22 years and oldest was 60 years.

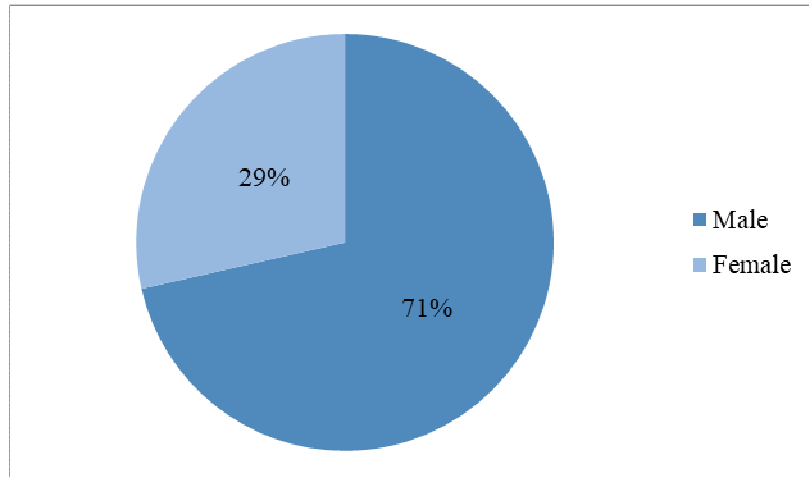


Figure-1: Pie diagram showing gender of the patient (N = 28) Majority 20 (71%) of the patients were male and the rest 8 (29%) were female.

Table-II: Side of the injured limb of the study subjects (N=28)

Side involvement	Frequency	Percentage (%)
Right	18	64.3
Left	10	35.7
Total	28	100.0

Table II shows out of the 28 patients, 18 (64.3%) presented with right sided ankle fracture and 10 (35.7) with left sided fractures.

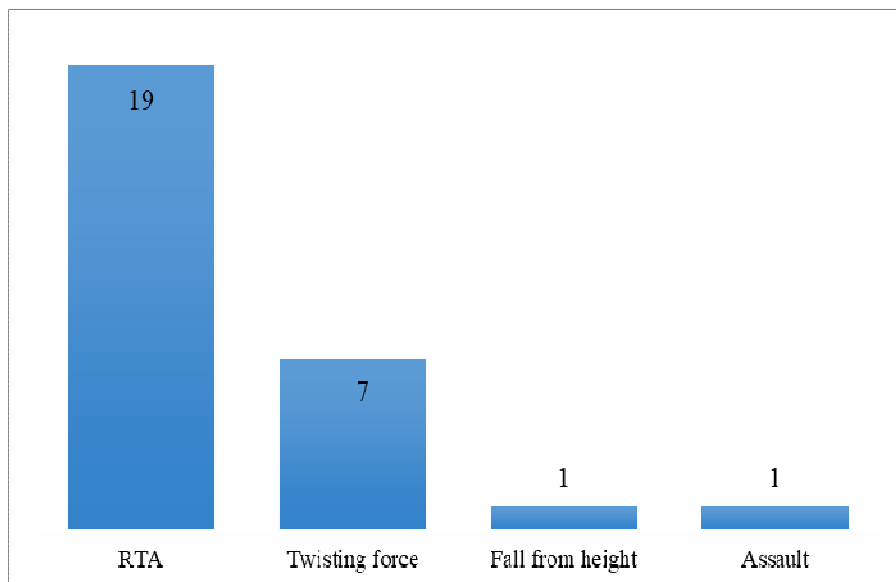


Figure-2: Bar diagram showing distribution of patients according to cause of injury (N=28) Vast majority 19 (67.9%) injuries were caused by RTA, 7(25%) were twisting fall, 1 (3.6%) was fall from height and another 1(3.6%) was due to physical assault.

Table-III: Time interval between injury and surgery of the study subjects (N=28)

Time interval between injury and surgery	Frequency	Percentage%
0-7 days	07	25
7-14 days	21	75
14-21 days	0	0
Total	28	100.0
Mean± SD		10.21+3
Range		4-14

Table III shows 7(25%) patients surgery was done within 1st week, 21(75%) patients done in 2nd week from the occurrence of injury.

The mean interval between injury and plate fixation was 10.21 ± 3 days, where minimum was 4 days and maximum was 14 days.

Table-IV: Complication of the study subjects (N=28)

Complications	Frequency	Percentage%
Superficial infection	2	7.14
Deep infection	0	0
Non union	0	0
Mal union	0	0
Talar shift	0	0
Skin necrosis	0	0
Implant failure	0	0

Table-V: Radiological healing of the study subjects (N=28):

Radiological healing time	Frequency	Percentage%
12 weeks	16	57.14
14 weeks	10	35.7
16 weeks	02	7.1
Mean± SD		13.34+1.56
Range		12-16

Table V shows 16(57.14%) patients had radiological evidence of healing at 12 weeks, 10(35.7%) had healing evidence at 14 weeks and in 2(7.1%) patients it was at 16 weeks.

Mean duration of appearing radiological healing was 13.34 ± 1.56 weeks range 12-16 weeks.

Table-VI: Functional activities of the study subjects (N=28)

Activity limitations, support requirement	Frequency	AOFAS Score	Percentage (%)
No limitations, no support	0	0	0
No limitation of daily activities, limitation of recreational activities, no support	27	727	96.4
Limited daily and recreational activities, cane	1	4	3.6
Severe limitation of daily and recreational activities, walker, crutches, wheelchair, brace	0	0	0

Table VI shows 27(96.4%) patients had no limitation on daily activities but had limitation on recreational activities.

Table-VII: Hospital stay of the study subjects (N=28)

Duration of Hospital stay(weeks)	Frequency	Percentage%
0-7 days	01	3.6
7-14 days	16	57.1
14-21 days	11	39.3
Total	28	100.0
Mean± SD		14.2+68
Range		7-17

Table VII shows 11(39.3%) patients stayed 3 weeks, 16(57.1%) patients stayed 2 weeks. 1(3.6%) patient stayed 1 week in Hospital.

Mean duration of hospital stay was 14±2.68 days with minimum of 7 days and maximum of 17 days.

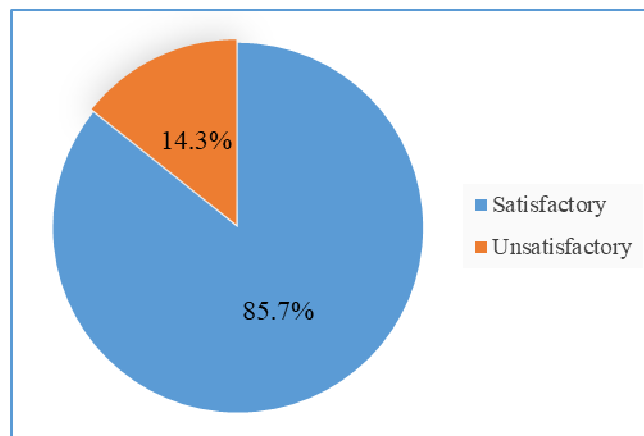


Figure-3: Pie diagram showing final outcome of the study subjects (N=28)

In this study, out of 28 patients, final outcome was satisfactory (Excellent 15 and Good 12) in 24 (85.7%) cases and Unsatisfactory (fair 5 and poor 0) in 4 (14.3%) cases according to American Orthopedic Foot and Ankle Score.

DISCUSSION

A total of 28 subjects were included in this study based on predefined enrolment criteria. In this study, the most affected age group was 18 to 30 years (50%) and the mean age was 34.68+ 10.79 years. A similar type of study was done by Kulloli, Magdum, and Naik et al. [9] in India where the study subjects were between 20 to 65 years. Maximum patients were included 28 to 37 years old age

groups with a mean age of 56.45 years. This observation was also consistent with many other studies done by Hafiz, et al. [10]; Alamgir, et al. [6]; Shekhar and Reddy [11]. These studies also showed a mean age of around 35. From this study, it is evident that the ankle fracture seems to occur in relatively younger people. There were 20 males (71%) and 8 female patients (29%) in this study. This observation was evident done by Shekhar and Reddy et al. [11] shown 83.3% were male and 16.7% were female. This is accompanying by other studies also [10]. The current study showed, among 28 patients 18 (64.3%) presented with a right-sided ankle fracture and 10 (35.7%) with left-sided fractures. A similar

study Hafiz, et al. [10] showed the right side was affected by 58.8% and left side 41.2% cases. This observation was also consistent with [12]. A study by Schepers, T. et al. [13] found that both sides were equally affected. Another study found that left-side was more involved than the right sides [9]. From this study, it is evident that the ankle fracture in our country seems to occur more on the right side. In this study, 19 (67.9 %) injuries were caused by RTA, whereas another recent study [11] showed 83.19% cases were due to road traffic accidents, our 16.6% cases were due to fall. Another study showed motor vehicle accident (MVA) was the most common cause of ankle fractures (70.4% of all study subjects) and 6.2% were sports injury [10]. The most common mechanism of Danis-Weber Type-C ankle fracture was Pronation external rotation. Mechanism of injury in this study by Pronation- external rotation was found 24(85.7%) cases among 28, which is supported by further research observation [14,15]. 24(85.7%) cases out of 28 patients had syndesmotom injury which was common in Danis Weber Type-C ankle fracture [16,17]. In this study 7(25%) patients' surgery was done within 1st week, 21(75%) patients did the procedure within 2nd week from the occurrence of injury and plate fixation; mean duration was 10.21±3 days, where the minimum was 4 days and the maximum was 14 days. In current study, the injury was not dealt with within a few hours due to blisters and soft tissue injury, definitive treatment was deferred for several days, while the leg was elevated so that the swelling could subside and skin wrinkle appears [18]. It is important to choose the best time for surgical treatment. Soft tissue determines the perfect time for the operation. In this study, 11(39.3%) patients stayed 3 weeks, 16(57.1%) patients stayed 2 weeks and 1(3.6%) patient stayed 1 week in Hospital. The mean duration of hospital stay was 14±2.68 days with a minimum of 7 days and a maximum of 17 days. A study in

Bangladesh showed duration of hospital stay was respectively 3.2 days and 4 days [6, 19]. Another Malaysian study revealed in most of the cases (74.4%) duration of hospital stay was less than 2 weeks [10]. In the current study 16(57.1%) patients had radiological evidence of healing at 12 weeks, 10(35.7%) had healing evidence at 14 weeks and in 2(7.1%) patients, it was at 16 weeks. The mean duration of appearing radiological healing was 13.34±1.56 weeks. This study corresponds with a study conducted by Tejwani, Park and Egol et al. [20] where delayed union rate was 30%. The mean duration of appearing radiological healing was 12.73 weeks, some researchers [8] showed in their study that the fibular fractures were healed without displacement at around 10 weeks. In our study 3(10.7%) patients could cross greater than 6 blocks by walking, 24(85.7%) patients could cross 4-6 blocks and 1(3.6%) patients could cross 1-3 blocks. (one block is equal to 200 meters). There was no gross restriction of movement. In a study Weening, et al. [16] showed that 22.5% of the patients developed a gross restriction of movement because of post-operative pain and stiffness. In this study 15(53.6%) patients had no difficulties in walking on any surfaces and 13(46.4%) patients had some difficulties in walking on uneven surfaces. Tunturi et al., [21] showed there were 27% of patients had difficulties walking on an uneven surface. The difficulty was due to poor alignment of the fracture fragments. During follow up 27(96.4%) patients had no limitation on daily activities but 1(3.6%) patient had a limitation on recreational activities. The functional scores of the patients in this study were high which was supported by a Chinese study [22]. According to the AOFAS Score, >90 was termed as excellent, 80-89 was good, 60-79 was fair and <60 was termed as poor outcome. In 12 weeks follow up, 4(14.3%) patients had excellent, 16(57.1%) patients had good and 8(28.6%) patients had a fair outcome. In 24 weeks follow up, 13(46.4%) patients had

excellent, 10(35.7%) patients had good and 5(17.9%) patients had a fair outcome. The average AOFAS score in 12 weeks follow up was 82 ± 8.50 and in 24 weeks follow up was 87 ± 9 . The P-value was 0.0005 (<0.05) which was statistically significant. So a total of 24(85.7%) patients were in the satisfactory group and only 4(14.3%) patients were in an unsatisfactory group. In a series Hafiz, et al. [10] showed in their study that 93% had satisfactory and the remaining 7% had unsatisfactory, which was nearer to this study.

CONCLUSION

The study shows that proper operative treatment of Danis-Weber type C ankle fracture by the selected implant leads to excellent to good radiological and functional results with uncomplicated recovery in the majority of the cases. Appropriate patient counselling is necessary to prepare patient ready for the expected functional outcome.

Conflict of Interest: None.

REFERENCES:

1. Singh, S., Dr. N. Sathish Kumar. (2018) 'Medical Science "Surgical management of closed bimalleolar ankle fractures by ORIF with fibular plating and TBW/screw fixation of medial malleolus-our experience "Dr. N. Sathish Dr. Satveer Singh', (2), pp. 8-10.
2. Walsh, A.S., Sinclair, V., Watmough, P. and Henderson, A.A., 2018, Ankle fractures: Getting it right first time. *The Foot*, 34, pp 48-52.
3. Anderson, S.A., Li, X., Franklin, P. and Wixted, JJ., 2008. Ankle fractures in the elderly: initial and long-term outcomes. *Foot & ankle international*, 29(12), pp.1184- 1188
4. Singh, R., Kamal, T., Roulohamin, N., Maoharan, G., Ahmed, B. and Theobald, P., 2014. Ankle fractures: a literature review of current treatment methods. *Open Journal of Orthopedics*, 4(11), pp.292-303.
5. Arastu, M.H., Demcoe, R. and Buckley, R.E., 2012. Current concepts review: anklefractures. *Acta Chir Orthop Traumatol Cech*, 79(6), pp.473-83.
6. Alamgir, M.H.M., Islam, M., Islam, M.N. and Kader, A., 2013. Open Reduction and Internal Fixation of Displaced Fractures of Lateral Malleolus by Tension and Wiring and Plating in Bimalleolar Fractures in Adults. *Journal of Shaheed Suhrawardy Medical College*, 5(2), pp.81-83.
7. Ebraheim, N.A. Mekhail, A.O. and Gargasz, S.S., 1997. Ankle fractures involving the fibula proximal to the distal tibiofibular syndesmosis. *Foot & ankle international*, 18(8), pp.513-521.
8. Siegel, J. and Tornetta III, P., 2007. Extraperiosteal plating of pronation-abduction ankle fractures. *JBJS*, 89(2), pp.276-281.
9. Kullooli, D.S.S., Magdum, D.P. and Naik, D.N.P., 2012. Evaluation of management of malleolar fractures of ankle joint. *IOSR Journal of Dental and Medical Sciences (JDMS) ISSN: 2279-0853, ISBN: 2279-0861. Volume, 3, pp.27-31.*
10. Ahmad Hafiz, Z. Nazri, M.Y., Azril, M.A., Kassim, N.A., Nordin, N., Daraup, S. and Premchandran, N., 2011. Ankle fractures: The operative outcome. *Malaysian orthopedic journal*, 5(1), pp.40-43.
11. Shekhar, D. V. and Reddy, D. V. G., 2017 'Outcome of Surgical Management of Bimalleolar Fractures - our Experience', *IOSR Journal of Dental and Medical Sciences*, 16(03), pp. 34-37.
12. Makwana, N.K., Bhowal, B., Harper, W.M. and Hui, A.W., 2001. Conservative versus operative treatment for displaced ankle fractures in patients over 55 years of age: a prospective, randomised study. *The Journal of bone*

- and joint surgery. British volume, 83(4), pp.525-529.
13. Schepers, T., 2011. To retain or remove the syndesmotic screw: a review of literature. Archives of orthopedic and trauma surgery, 131(7), pp.879-883.
 14. Bekerom, M.P.V.D. and Raven, E.E., 2007. Current concepts review: operative techniques for stabilizing the distal tibiofibular syndesmosis: Foot & ankle international, 28(12), pp.1302-1308.
 15. Riegels-Nielsen, P., Christensen, J. and Greiff, J., 1983. The stability of the tibio- fibular syndesmosis following rigid internal fixation for type C malleolar fractures: an experimental and clinical study. Injury, 14(4), pp.357-360.
 16. Weening, B. and Bhandari, M., 2005. Predictors of functional outcome following transsyndesmotic screw fixation of ankle fractures. Journal of orthopedic trauma, 19(2), pp.102-108.
 17. Hamid, N., Loeffler, B.J., Braddy, W., Kellam, J.F., Cohen, B.E. and Bosse, M.J., 2009. Outcome after fixation of ankle fractures with an injury to the syndesmosis: the effect of the syndesmosis screw. The Journal of bone and joint surgery. British volume, 91(8), pp. 1069-1073.
 18. Bowyer, G. (2017) Injuries of the ankle and foot. In: Blom, A., Warwick, D., Whitehouse, M. R., eds. 2017. Apley & Solomon's System of Orthopaedics and Trauma 10th edition. Boca Raton: CRC Press, pp. 942-946.
 19. Lamontagne, J., Blachut, P.A., Broekhuysen, H.M., O'Brien, PJ, and Meek. R.N. 2002. Surgical treatment of a displaced lateral malleolus fracture: the antiglide technique versus lateral plate fixation. Journal of orthopedic trauma, 16(7), pp.498- 502
 20. Tejwani, N.C., Park, J.H. and Egol, K.A., 2015. Supination external rotation ankle fractures: a simpler pattern with better outcomes. Indian journal of orthopaedics, 49(2), p.219.
 21. Tunturi, T., Kemppainen, K., Pätäälä, H., Suokas, M., Tamminen, O. and Rokkanen, P. 1983. Importance of anatomical reduction for subjective recovery after ankle fracture. Acta Orthopaedica Scandinavica, 54(4), pp.641-647.
 22. Huang, Z., Liu, L., Tu, C., Zhang, H., Fang, Y., Yang, T. and Pei, F., 2014. Comparison of three plate system for lateral malleolar fixation. BMC musculoskeletal disorders, 15(1), p.360.
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