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Comparative study of tension band wiring and malleolar screw fixation for the treatment of medial malleolus fracture

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Abstract

Background: Malleolar fractures are the most common type of ankle fractures. These intra-articular fractures need to be managed properly as they have high chance of non-union and are usually treated operatively. Open reduction and internal fixation with malleolar screw or tension band wiring (TBW) are mostly used treatment modalities for medial malleolus fracture. The objective of this study was to compare the functional and radiological outcome of patient who underwent TBW or malleolar screw fixation.

Methods: It was a prospective comparative study conducted in 40 patients at Gandaki Medical College over the period of 24 months. Patients fulfilling the inclusion criteria were included in the study. 20 patients were randomly selected in either group of malleolar screw and TBW which were followed for six months postoperatively. Functional outcome was measured using Olerud and Molander scoring system. Radiological outcome, adverse radiological outcome, range of motion and complications were studied and compared.

Results: The mean age of TBW group was 41.3 ± 14.76 while in malleolar screw group it was 39.65 ± 15.34 . Male to female ratio in TBW group and malleolar screw group was 0.82 and 0.66 respectively which is not statistically significant. Mode of injury, fracture type pre and postoperative hospital stay and duration of surgery were statistically similar in both the groups. Most common mode of injury was RTA (50%) and twisting of ankle (35%). Higher rate of smoking was seen in malleolar screw group (40%) than in TBW group (20%) while alcohol consumption was seen in 40% TBW patients and 15% malleolar screw patients. Average duration of bony union was significantly higher in TBW group (8.32 ± 1.61 weeks) compared to malleolar screw fixation group (10.69 ± 3.35 weeks) ($P=0.008$), however there is no significant difference in term of functional outcome score, radiological outcome and complication rate.

Conclusions: There is no significant difference in term of functional outcome and complication rate between TBW or malleolar screw fixation for medial malleolus fracture however, patients treated with TBW fixation tend to show earlier radiological union.

Keywords: ankle fracture, medial malleolus, TBW, malleolar screw, functional outcome

Introduction

Ankle is a hinge like joint which transmits the body weight to foot and ground. Ankle joint is formed by two parts which interlock like a mortise (distal ends of the tibia and fibula) and tenon (talus) which are stabilized statically by medial, lateral collaterals and distal tibiofibular syndesmosis^[1, 2]. Injuries to ankle could be ligamentous, bony or combined. Ligament injury (ankle sprains) might lead to ankle instability. Most commonly lateral collateral (75%) especially anterior talofibular (ATFL) ligament is injured. Medial ligament injuries are usually associated with a fracture or joint injury^[3].

Ankle fractures are common and could be due to low or high velocity trauma. Medial malleolus fracture could be isolated or associated with other fractures around ankle. Isolated medial malleolus which is undisplaced could be managed conservatively^[4]. Displaced medial malleolus fracture warrant surgical management as the persistent displacement allows the talus to tilt into varus. Similarly, there are high chances of soft tissue interposition especially the

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thick periosteum between the fracture fragments. This might lead to nonunion of the fracture [5].

Fixation of medial malleolus could be done in many ways. Cannulated cancellors screw (CCS), 4 mm partially threaded cancellous lags crew (malleolar screw) or 3.5mm bicortical lag screws could be used for screw fixation. Two lag screws could be used for bigger fragments while one screw with one Kirschner wire (K wire) could also be used to prevent the rotation. Other options for fixation include Tension Band Wiring (TBW). In TBW stainless steel (SS) wire could be used for this purpose but now a days bioabsorbable implants have come to light as it possess less hardware irritation. Drawbacks like drainage from sterile sinuses has been reported in 5% to 10% of patients possibly related to the breakdown of polyglycolide and local inflammatory tissue reaction. Other options could be lag screw or lag screw with buttress plate for vertically oriented or oblique fractures [5, 6]. Among these fixation methods malleolar screw and TBW of the most commonly used fixation technique. In this study, we are trying to analyze the effectiveness of both well accepted malleolar screw fixation and TBW technique for fixation of medial malleolus fracture.

Methodology

This was a prospective comparative study of 60 patients who underwent operative fixation of medial malleolus fracture using malleolar screw and TBW. This study was conducted between July 2018 to July 2020 at Gandaki Medical College,

Pokhara. Ethical permission was obtained from Institutional Review Committee of Gandaki Medical College. Written consent was obtained from the patients prior to data collection.

30 patients were randomly selected in either group of malleolar screw and TBW fixation. We included skeletally mature patients with closed ankle fracture who underwent operative treatment. Patients with open fracture, polytrauma, pillion fracture and previous history of ankle fractures were not included in our study. Follow up was done at 4weeks, 6 weeks, 3 months and 6 months postoperatively. For malleolar screw fixation technique, a single 4 mm partially threaded malleolar screw and one 1.8mm k-wire was used. In TBW fixation technique, TBW with SS wire was used. Standard medial approach was used for both type of fixation Fig.1.

Data was recorded in self designed proforma. Ankle range of motion was measured using goniometer in supine position and functional outcome was measured using visual analogue score (VAS) and Olerud-Molander Ankle Score (OMAS). Serial radiographs were taken to look for union, other bony changes and hardware status in each follow up. Range of motion of ankle was measured at 6 months. Complications were noted in each follow up. Data was entered in MS-excel 2010 and analysed using SPSS v 25. Chi square test, student's t-test and ANOVA test were used to compare between different groups. Level of statistical significance was kept at 5%.



Fig 1

Results

Among all participants 42.5% were male and 57.5% were female. Most common age group was 20-40 years of age with mean age of 41.3±14.96 years with no significant difference in male and female. Mode of injury was RTA in 50% of cases followed by twisting of ankle in 35% and fall from height in 15% of cases. 30% of the participants were smokers while 27.5% of the participants consumed alcohol.

Fracture classification was done using LAuge Hansen classification. Supination external rotation (SER) was the most common type (57.5%) followed by pronation external rotation (25%), supination adduction and pronation abduction (17.5%) injuries. Fig.2. Right side was injured in 57.5% of the cases while left side was involved in 42.5% of the cases.

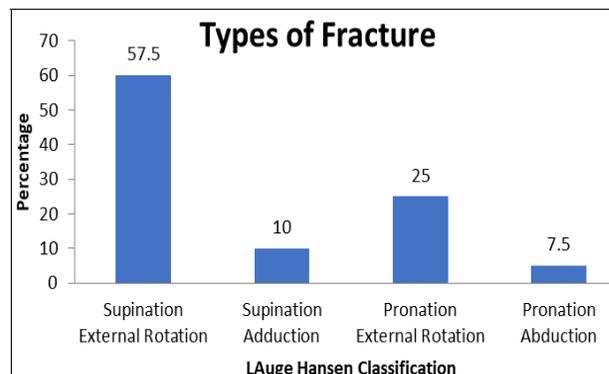


Fig 2: Fracture type

Regarding fixation, it was the operating surgeon's choice of fixation which included malleolar screw in 50% patients, TBW in 50% patients for medial malleolus fracture. Lateral malleolus fixation was done with 1/3rd semi tubular plate in 90% of cases, small DCP in 8% and intramedullary rush pin in 2% of cases. Syndesmotic fixation was done if intraoperative stress test for injury was positive and it included 12.5% of the cases. Mean pre-operative hospital stay was 3.9±1.34 days while total duration of hospital stay was 8.9 ±1.7 days which was similar in patient treated with TBW or malleolar screw (p=0.223). Similarly mean duration of surgery was 68.7±15.05 minutes with no statistically significant difference between two treatment groups. Outcomes were measured using VAS score at each follow up. Duration for radiological union, range of motion of ankle, Olerud and Molander score and complications at 6 months. Comparison of outcome between patients treated with TBW or screw fixation for medial malleolus was also done.

The mean postoperative VAS score was 5.04±1.8 at first post-operative day with similar distribution in TBW (4.63±1.68) and malleolar screw group (5.52±1.55) (p=0.114). VAS score was taken in each follow up which was also similar in both the groups.

In 6 months mean ankle range of motion in operated side was 24.40±2.43 degrees of dorsiflexion and 33.1±2.4 degrees of plantar flexion. In between patients treated with TBW and screw fixation the mean ankle dorsiflexion was 23.4±25 and 25.1±15 degrees respectively and the difference was not significant (p=0.179). Similarly for ankle plantar flexion the range of motion was 32.75±2.5 degrees in TBW group vs. 33.38±3.4 degrees in screw fixation group (p=0.231)

Mean duration for union was 9.50±2.18 weeks. Union in TBW group (8.32 weeks) was found to be earlier compared to malleolar screw group (10.69 weeks) which was statistically significant (p=0.008).

Table: 1

Table 1

Group	Minimum	Maximum	Union Duration in weeks	Students T test
Total	6	12.43	9.50±2.18	P=0.008
TBW	5.71	16	8.32±1.32	
Malleolar screw	5.71	16	10.69±2.43	

85% of patient had good to excellent result while 15% had fair outcome based on Olerud and Molander Score. In TBW group 90% had good to excellent outcome while 80% had good to excellent outcome in malleolar group. The outcome

was similar in both the groups and there was no statistically significant difference (p=6.12).

Table: 2

Table 2

Group Outcome	Tension Band Wiring	Malleolar Screw	Total	P value*
Excellent	9 (30%)	6 (20%)	15 (25%)	0.612
Good	18 (60%)	18 (60%)	36 (60%)	
Fair	3 (10%)	6 (20%)	9 (15%)	
Total	30 (100%)	30 (100%)	60 (100%)	

*Fisher Exact Test

Overall, 8.3% of the patient had complications related to surgery. In TBW group there were 2 patients with surgical site infection and 1 patient with marginal skin necrosis. In malleolar screw group 1 patient had multiple complications (iatrogenic comminution of fracture, surgical site infection and implant failure) while other 1 had skin necrosis.

Discussion

Overall 90% of the patients are between 20-50 years which is similar to other studies [6, 7, 8]. Dhoju D. mentioned significant difference between male and female with female being older than male. Our study also has shown less incidence in female but was not significantly different (p=0.108) [9].

Regarding gender distribution female (57.5%) were more injured than males (42.5%) with male to female ratio of 0.82 in TBW group and 0.66 in malleolar screw group. Dhoju D., Jain *et al.* and Kanth *et al.* showed more male than female while Mohammed *et al.* and Khachariya *et al.* showed more female than male [9, 10, 11, 12, 13].

In our study mean hospital stay was 8.9 days ranging from 6 to 13 days (8.55±1.90 days in TBW group, 9.25±1.62 days in malleolar screw group). Kanth *et al.* had his surgery done by 2 to 15 days with an average of 8 days [11]. In a study done by Motwani *et al.* most of the cases were operated between days 2 and 5 (77.5%) mean time interval was 3.5 days [14]. These findings are comparable to our findings. Both of these studies didn't look for association of outcome with duration of

surgery from injury.

Studies have shown that early surgery can minimize the length of hospital stay and a delay of more than a week significantly increases postoperative infection [15, 16, 17]. Study done by Singh *et al.* in 2015 also reported mean length of stay to be 8 days; 4.5 days preoperatively and 3.5 days post operatively with shorter hospital stay in early surgery than delayed surgery [16]. He has defined early surgery as less than 24 hours and late as more than 24 hours but other literatures have defined differently; Study by Tantigate D. *et al.* defined delayed surgery as time between injury and surgery greater than 14 days while Konrath. G. *et al.* defined early as less than 5 days and delayed as more than 5 days [18, 19]. So, the terms early and delayed surgery can give rise to confusion if duration is not mentioned. Tantigate D. *et al.* didn't find high rate of wound complications if surgery was delayed with equal functional outcome in a retrospective study done among 121 patients who underwent ankle ORIF [18]. Konrath. G. *et al.* did a retrospective study among 202 closed bimalleolar fractures and didn't find any significant difference in results among early vs late surgery [19]. We performed all surgeries after 24 hours (2 to 8 days) post trauma. In general long hospital stay with delayed surgery is due to initial swelling, blistering. This can be reduced by discharging the patient and planning for semi elective surgery [19]. We did not do any objective evaluation of swelling and could not conclude about relationship between amount of swelling with duration of

hospital stay and post-operative outcomes.

Regarding mode of injury RTA (60%) was most common followed by twisting of ankle (35%) and fall from height (15%). 1 patient also had mild head injury while 1 other had mild head injury with left maxillary and sinus wall fracture. Both cases were treated with TBW. Study done by Mohammad A *et al.* and Dhoju D has shown twisting of ankle being most common followed by fall and motor vehicle accident [9, 12]. Most of the studies have shown right side being significantly common [10, 12, 14].

Smoking is one of the preventable risk factors in orthopaedic surgery. It is related to both anaesthesia related complications and adverse effect on bone healing and are 4.3 times more likely to develop infections, poor bone fusion or delayed bone formation [20, 21]. If we look at the results from this study overall 30% were smoker which included 20% in TBW group and 40% in malleolar screw group. The mean union time was earlier in non-smokers (9.04±2.5 weeks) compared to smokers (10.6±3.3 weeks) but was not statistically significant (T test, p=0.17). Here we have not quantified smoking in terms of amount and duration of smoking so quantitative relation between smoking and union could not be analysed in our study.

In general alcohol abusers are difficult to treat due to lack of co-operation, liability to further trauma and osteoporosis [22, 23]. In our study there was no significant difference between alcohol consuming group and those who did not consumed alcohol in terms of duration of union (T test, p=0.824).

Regarding Lauge Hansen classification, SER accounts for most fracture with frequency of around 40 to 70% [5, 24, 25]. Other comparative studies between different fixation methods mainly TBW vs screw fixation has also reported SER to be the most common type. Kanth CH *et al.* reported SER in 50% and 60%, SAD in 20% and 20%, PAB in 20% and 10% and PER in 10% and 10% among TBW and screw fixation group respectively [11]. Similar finding of SER being the most common (40-60%) pattern was reported by Hussain J and Motwani *et al.* [8, 14]. In this study most common fracture type was SER (57.5%) injury as in Lauge Hansen classification. The distribution between two groups in our study showed SER in 55% and 60%, PER in 40 and 10%, SAD in 0% and 20% and PAB in 5% and 10% among TBW and malleolar screw group respectively without statistically significant difference. These findings are consistent with previous studies.

Average duration of surgery was 85.83 ± 15.79 minutes with 88.90±15.05 minutes taken in TBW group and 82.75 ± 16.29 minutes in malleolar screw group. Konrath, G *et al.* reported average duration of surgery of 118 minutes in early group vs. 128 minutes in delayed group [19]. He included only bimalleolar fractures, so the duration might have been slightly longer compared to our study. In our study we have included isolated medial malleolus fracture which have significantly lower duration of surgery compared to bimalleolar surgery (T test, p=0.050).

Outcome measure included time for radiological union, adverse radiologic outcome, range of motion at 6 months, Modified Ankle Score of Olerud and Molander at 6 months and complications.

Bony union in TBW group (8.32±1.61 weeks) was significantly faster than the malleolar screw group (10.69±3.35 weeks). There was no non-union in both groups. Mohammed AA *et al.* showed earlier union time in TBW group (9.4 weeks). Similar finding with significant earlier union rate in TBW compared to screw fixation group was

shown by other studies [8, 12, 13]. Among these studies Hussain J compared TBW with malleolar screw while others have compared TBW with screw fixation (screw fixation included Cannulated screws, lag screws, malleolar screw or mixed). (8) All these findings are consistent with findings of our study. Earlier union rate in TBW could be due to its four times stiffer construct in resistance to pronation compared with K wire and two cancellous screws in medial malleolus fracture fixation. Similar study in cadavers, done by Johnson BA & Fallat LM showed lower mean force required for clinical failure for cannulated screws compared to TBW. TBW is especially useful for small fragments and in osteoporotic bone [5, 26, 27].

Radiological outcome was defined as adverse if >2 mm of articular steps, intra-articular bone fragments, or an articular surface gap of >2 mm was present at any duration. 95% had no adverse radiological outcome. No patients in TBW group had adverse radiological outcome while 2 patients in malleolar screw group had >2mm of articular stepping. One of the patients was 74 years old who had intraoperative comminution and screw pullout after weight bearing. She was managed with malleolar screw. This was probably due to weak bone density and inappropriate fixation method as TBW is recommended in osteoporotic bone [24, 26].

The range of motion compared with normal side significantly decreased at 6 months after the surgery. The significant post-operative decrease in range of motion at 6 months in the presence of anatomical fixation might be due to non-adherence to physiotherapy/ROM exercises. Though ROM exercises were taught from 4th week postoperatively, the compliance is not known and looked after.

Olerud and Molander ankle score are commonly used to evaluate subjectively scored function after ankle fracture and hence used in our study also. In our study good to excellent results were seen in 90% of TBW patients and 80% of malleolar screw patients. There was no statistically significant difference between two groups and outcome score. Other studies also have shown similar findings with good to excellent results in 80-90% of TBW patients and 80% of screw fixation patients using Olerud and Molander ankle score [8, 10, 11, 12, 14, 28, 29]. Dhoju D. used AOFAS (AO Foot and Ankle Score) score to evaluate the outcome and found most patients had excellent results with mean score of 90.56±10.92 out of 100. He did not compared the outcome between treatment groups [9].

Overall 8.3% of patients had complications. In TBW group 2(6.6%) patient had surgical site infection and 1(3.3%) patient had marginal skin necrosis, while in malleolar screw group 1(3.3%) patient had iatrogenic comminution of fracture, surgical site infection and implant failure while other 1(3.3%) had skin necrosis. Surgical site infection was superficial in all cases and managed with antibiotics and dressing. Motwani *et al.* reported 17.5% of his patients developing complications which included superficial skin infection, deep infection and delayed union. He also described the association between complication and poor functional outcome [14]. We had a case of iatrogenic fracture in a 74 year old lady patient treated with malleolar screw and similar finding of comminution or crushing of medial malleolus in osteoporotic bone treated by screw fixation was described by Khachariya *et al.* Complication rate in study by Dhameeliya *et al.* was damage to vein in 8%, difficult closure in 12%, infection in 14%, painful hardware in 6%, loss of reduction in 2% and non-union in 2%. He did not compared complications between two groups [13, 29]. In general we had similar rate of complications but we

did not encounter non-union and symptomatic or painful hardware in our patients

Conclusions

Medial malleolus fracture Fixation can be done with various methods among which TBW and malleolar screw with equally good range of motion, functional outcome and low complication rate. Postoperative and follow up pain in both the group were also similar. However, there is a slightly earlier union rate in TBW group compared with malleolar screw group. Both the surgical methods can be used for fixation of medial malleolus fracture. However in osteoporotic fracture, TBW seems to be a better option. Larger studies with more sample size or a randomized control trial between fixation methods should be done to determine the optimal fixation method in medial malleolus fracture. A large epidemiological study is required to know the baseline data of Nepalese people. For example, the range of motion of ankle in Nepalese population would have helped to compare the findings with the nearest population means.

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