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Comparison of outcome of 4mm cancellous screws versus tension band wiring in patients with medial malleolar fractures

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ABSTRACT

INTRODUCTION: Medial malleolus fracture is commonly seen nowadays in orthopaedic practice. There are different modalities of treatment based on fracture pattern, socio-economic status. Un-displaced fracture can be managed by cast application. Various surgical modalities of treatment are available in treating medial malleolus fracture like tension band wiring, cancellous screw or cortical screw fixation, plate fixation, k-wire, suture anchors. The purpose of our study was to compare functional outcome of medial malleolar fracture managed with tension band wiring and cancellous screw fixation.

OBJECTIVE: To compare the outcome of 4mm cancellous screws versus tension band wiring in patients with medial malleolar fractures (supination-external rotation type-III and IV)

STUDY SETTING: The study was conducted in Orthopaedic Unit-I, Mayo Hospital, Lahore.

DURATION OF STUDY: March 16, 2021 to September 16, 2021

STUDY DESIGN: Randomized controlled trial

SUBJECTS & METHODS: Total 114 patients (57 in each group) having supination-external rotation fractures were enrolled. The patients were randomly divided into two treatment groups using lottery method as follows. Group A= 4mm cancellous screws and Group B= tension band wiring.The patients were evaluated functionally using a modification of the scoring system Proposed by Olerud and Molander. The data were analyzed by SPSS v25.0. Chi-square test was used to compare the outcome in two groups. Data were stratified for gender, age, type of fracture and BMI. Post-stratification, Chi-square test was applied. A *p-value* ≤ 0.05 was considered as significant.

RESULTS: Total 114 patients having Supination-External rotation fractures (Lauge-Hansen classification) were enrolled in this study. Patients were divided into two groups i.e. Group-A (Malleolar screw) and Group-B (Tension band wiring).Mean age in group-A patients was 43.02±15.55 year and 44.28±14.05 year in group-B patients. According to functional outcome, in Malleolar screw group, 22(38.6%) had excellent outcome, while 12(21.1%), 19(33.3%) and 4(7.0%) had good, fair and poor outcomes respectively, while in Tension band wiring group, 38(66.7%) had excellent outcome, while 11(19.3%), 6(10.5%) and 2(3.5%) had good, fair and poor outcomes respectively with a p-value of 0.008, which is statistically significant.

CONCLUSION: Tension-band wiring more valid option for internal fixation of medial malleolar fractures and more technically advantageous for small fragment fixation of medial malleolar fractures. The tension-band wiring may be more available and its usage could translate into overall cost saving when applied to the large number of ankle fractures treated surgically.

KEY WORDS:*Ankle Fracture, Tension Band Wiring, Malleolar Screw, Modified Olerud and Molander Ankle Score.*

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INTRODUCTION

Ankle fractures are one of the most common lower extremity fractures treated in orthopedics and during the last decades, the trend towards surgical treatment has increased.[1] The aim is to restore normal anatomy and biomechanics of the joint.[2] Fractures in general have been identified as a medical problem throughout history and most of Hippocrates essays described the management of injuries, especially fractures and stated that they were sometimes in connection with the skin. In the treatment he separated between injuries with and without lesions of the skin. In the former, reduction was not performed as the patient would die within seven days.[3]

Although Hansmann described the first internal fixation by means of plate and screws in 1858, Arbuthnot Lane and Albin Lambotte developed this method further.[4-5] The first case of surgery in the talocrural joint was reported by von Volkmann in 1875.[6] Initially however, surgical techniques of fracture treatment did combine the disadvantages of non-surgical and operative treatment: the osteosynthesis was unstable and the fracture site had been exposed with a high risk of infection and disturbed bone healing.[6]

Medial malleolus fractures are commonly seen nowadays in orthopedic practice.[7-8] There are different modalities of treatment based on fracture pattern, socio-economic status. Un-displaced fracture and isolated medial malleolus fracture can be managed by cast application.[9] Various surgical modalities of treatment are available in treating medial malleolus fracture like tension band wiring, cancellous screw or cortical screw fixation, plate fixation, k-wire, suture anchors.[10-12]

Tension band wire fixation provides greatest resistance to pronation forces.[10] Tension band fixation of the medial malleolus is a biomechanically strong and clinically acceptable method of treatment for displaced comminuted medial malleolus fractures. This technique is also suitable if distal component of the fracture is of smaller size.[10] Cancellous or cortical lag screws placed perpendicular to fracture surface showed good results for stabilization of vertical shear fractures of the medial malleolus.[13]

In a study, with malleolar screw, 69.23% rated excellent, 16.67% rated good, 10.77% rated fair and 3.33% rated poor, while with tension band wiring, 88.23% rated excellent, 5.67% rated good, 2.1% rated fair and 5% rated poor.[14] In another study, with malleolar screw, 10% rated excellent, 70% rated good, 10% rated fair and 10% rated poor, while with tension band wiring, 20% rated excellent, 70% rated good, 10% rated fair and 0% rated poor.[15] Fracture union was 100% in tension band wiring group and in malleolar screw group was 96.66%.[16]

A possible explanation for this conflict could be difference in surgical technique among various researchers. To the best of candidate's knowledge, there is no local published study on this topic. Owing to lack of local research and the conflict among existing international literature, the purpose of repeating this study to determine the better treatment option between malleolar screw and tension band wiring in patients with medial malleolar fractures. The results of this study will help in better management of such patients in future practice.

MATERIALS AND METHODS

Study Setting:

The study was conducted in Orthopaedic Unit-I, Mayo Hospital, Lahore.

Study Duration:

March 16, 2021 to September 16, 2021

Study Design:

Randomized controlled trial

Sampling Technique:

Non-probability consecutive sampling

Sample Size:

The sample size of 114(57 in each group) was estimated by using 5% level of significance and 80% power of test with an expected percentage of excellent outcome as 69.23% with malleolar screw and 88.23% with tension band wiring.[14]

SAMPLE SELECTION

Inclusion Criteria:

- Patients of both genders
- Aged between 18-70 years
- Patients with Supination-External rotation fractures (Lauge-Hansen classification)

Exclusion Criteria:

- Compound fractures
- Associated with other fractures
- Traffic-, bicycle- or pedestrian- accidents, and falling other than at the same level.

DATA COLLECTION PROCEDURE

After taking approval from Hospital Ethical Committee, 114 patients (57 in each group) presented in the Department of Orthopaedic, who met the inclusion criteria were enrolled into this study. Written informed consent and detailed history were taken from every patient. The patients were randomly divided into two treatment groups using lottery method as follows. Group A= 4mm cancellous screws and Group B= tension band wiring.

After pre-operative assessment, patients were taken to operation theatre and adequate anaesthesia was given. After routine skin preparation and draping, anteromedial incision was done that begin approximately 2 cm proximal to the fracture line, extended distally and slightly posteriorly, and ended approximately 2 cm distal to the tip of the medial malleolus.

In group-A patients, 3.2 mm hole was drilled while distal fragment was held reduced with a pointed clamp or with two Kirschner wires bent to stay out of way as temporary fixation devices. Length of hole was measured, and a 4 mm cancellous screw with washer was inserted. In group-B, the fracture was internally fixed with two mm smooth Kirschner wires drilled perpendicular to the fracture line. The Kirschner wires should be parallel, and their ends were bent at 90° angles.

A stainless steel 1.2-mm AO wire was passed through the previously drilled hole and around the bent ends of the Kirschner wires in a figure-of-eight configuration. Fibula was managed by 1/3 tuber plate. The patients were evaluated functionally using a modification of the scoring system Proposed by Olerud and Molander. The scores for each component of this scale were assessed by the use of a questionnaire.

The scoring scale had a maximum of 100 points (>91 excellent results, 81-90 good results, 71-80 fair results, <70 poor results). All the data were collected through a pre-designed proforma (attached).

DATA ANALYSIS PLAN

The data were analyzed by SPSS v25.0. Mean±S.D for the quantitative variables i.e. age and BMI were calculated. Frequency and percentages were presented for all the categorical variables including gender, union, type of fracture and outcome. Chi-square test was used to compare the outcome in two groups. Data were stratified for gender, age, type of fracture and BMI. Post-stratification, Chi-square test was applied. A *p-value* ≤0.05 was considered as significant.

RESULTS

Total 114 patients having Supination-External rotation fractures (Lauge-Hansen classification) were enrolled in this study. Patients were divided into two groups i.e. Group-A (Malleolar screw) and Group-B (Tension band wiring).In group-A, there were 34(59.6%) males and 23(40.4%) females, while in group-B, there were 41(71.9%) males and 16(28.1%) females **(Table-1)**.

Mean age in group-A patients was 43.02±15.55 year and 44.28±14.05 year in group-B patients. In group-A, 14(24.6%) were in 18-30 years age group, while 14(24.6%) and 29(50.9%) in 31-45 years and >45 years age groups respectively. In group-B, 13(22.8%) were in 18-30 years age group, while 17(29.8%) and 27(47.4%) in 31-45 years and >45 years age groups respectively **(Table-2)**.

In group-A, 37(64.9%) had normal BMI, while 14(24.6%) and 6(10.5%) were overweight and obese

respectively, while in group-B, 36(63.2%) had normal BMI, while 18(31.6%) and 3(5.3%) were overweight and obese respectively **(Table-3)**.
According to type of fracture distribution, 24(42.1%) had type-III fracture and 33(57.9%) had type-IV fracture in group-A, while in group-B, 26(45.6%) had type-III fracture and 31(54.4%) had type-IV fracture **(Table-4)**.
According to functional outcome, in Malleolar screw group, 22(38.6%) had excellent outcome, while 12(21.1%), 19(33.3%) and 4(7.0%) had good, fair and poor outcomes respectively, while in Tension band wiring group, 38(66.7%) had excellent outcome, while 11(19.3%), 6(10.5%) and 2(3.5%) had good, fair and poor outcomes respectively with a p-value of 0.008, which is statistically significant **(Table-5)**.
According to union distribution, 57(100.0%) had union in group-A, while in group-B, 56(98.2%) had union **(Table-6)**.
According to stratification of functional outcome between groups with respect to gender, significant results were observed in male patients **(Table-7)**.
According to stratification of functional outcome between groups with respect to age, significant results were observed in >45 years age group **(Table-8)**.
According to stratification of functional outcome between groups with respect to BMI, significant results were observed in overweight group **(Table-9)**.
According to stratification of functional outcome between groups with respect to type of fracture, significant results were observed in type-III fracture **(Table-10)**.

Table-1: Comparison of gender distribution between groups

Gender	**Groups**		**Total**
	Tension band wiring	Malleolar screw	
Male	41	34	75
	71.9%	59.6%	65.8%
Female	16	23	39
	28.1%	40.4%	34.2%
Total	57	57	114
	100.0%	100.0%	100.0%

Table-2: Comparison of age distribution between groups

Age groups	**Groups**		**Total**
	Tension band wiring	Malleolar screw	
18-30 years	13	14	27
	22.8%	24.6%	23.7%
31-45 years	17	14	31
	29.8%	24.6%	27.2%
>45 years	27	29	56
	47.4%	50.9%	49.1%
Total	57	57	114
	100.0%	100.0%	100.0%

Table-3: Comparison of BMI distribution between groups

Body Mass Index (BMI)	**Groups**		**Total**
	Tension band wiring	Malleolar screw	
Normal (18-24.9)	36	37	73
	63.2%	64.9%	64.0%

Overweight (25-29.9)	18	14	32
	31.6%	24.6%	28.1%
Obese (>30)	3	6	9
	5.3%	10.5%	7.9%
Total	57	57	114
	100.0%	100.0%	100.0%

Table-4: Comparison of type of fracture between groups

Type of fracture	**Groups**		**Total**
	Tension band wiring	Malleolar screw	
Type-III	26	24	50
	45.6%	42.1%	43.9%
Type-IV	31	33	64
	54.4%	57.9%	56.1%
Total	57	57	114
	100.0%	100.0%	100.0%

Table-5: Comparison of functional outcome between groups

Functional outcome	**Groups**		**Total**	**p-value**
	Tension band wiring	Malleolar screw		
Excellent	38	22	60	0.008
	66.7%	38.6%	52.6%	
Good	11	12	23	
	19.3%	21.1%	20.2%	
Fair	6	19	25	
	10.5%	33.3%	21.9%	
Poor	2	4	6	
	3.5%	7.0%	5.3%	
Total	57	57	114	
	100.0%	100.0%	100.0%	

Table-6: Comparison of union between groups

Union	**Groups**		**Total**	**p-value**
	Tension band wiring	Malleolar screw		
Yes	57	56	113	0.315
	100.0%	98.2%	99.1%	
No	0	1	1	
	0.0%	1.8%	0.9%	
Total	57	57	114	

	100.0%	100.0%	100.0%	

Table-7: Stratification of functional outcome between groups with respect to gender

Gender	**Functional outcome**	**Groups**		**Total**	**p-value**
		Tension band wiring	Malleolar screw		
Male	Excellent	30	18	48	0.050
		73.2%	52.9%	64.0%	
	Good	7	5	12	
		17.1%	14.7%	16.0%	
	Fair	4	11	15	
		9.8%	32.4%	20.0%	
	Total	41	34	75	
		100.0%	100.0%	100.0%	
Female	Excellent	8	4	12	0.149
		50.0%	17.4%	30.8%	
	Good	4	7	11	
		25.0%	30.4%	28.2%	
	Fair	2	8	10	
		12.5%	34.8%	25.6%	
	Poor	2	4	6	
		12.5%	17.4%	15.4%	
	Total	16	23	39	
		100.0%	100.0%	100.0%	

Table-8: Stratification of functional outcome between groups with respect to age

Age groups	Functional outcome	Groups		Total	p-value
		Tension band wiring	Malleolar screw		
18-30 years	Excellent	11	11	22	0.686
		84.6%	78.6%	81.5%	
	Good	2	3	5	
		15.4%	21.4%	18.5%	
	Total	13	14	27	
		100.0%	100.0%	100.0%	
31-45 years	Excellent	12	4	16	0.062
		70.6%	28.6%	51.6%	
	Good	2	5	7	
		11.8%	35.7%	22.6%	
	Fair	3	5	8	
		17.6%	35.7%	25.8%	
	Total	17	14	31	
		100.0%	100.0%	100.0%	
>45 years	Excellent	15	7	22	0.010
		55.6%	24.1%	39.3%	
	Good	7	4	11	
		25.9%	13.8%	19.6%	
	Fair	3	14	17	
		11.1%	48.3%	30.4%	
	Poor	2	4	6	
		7.4%	13.8%	10.7%	
	Total	27	29	56	
		100.0%	100.0%	100.0%	

Table-9: Stratification of functional outcome between groups with respect to BMI

Body mass index (BMI)	Functional outcome	Groups		Total	p-value
		Tension band wiring	Malleolar screw		
Normal	Excellent	27	21	48	0.237
		75.0%	56.8%	65.8%	

	Good	6	12	18	
		16.7%	32.4%	24.7%	
	Fair	3	4	7	
		8.3%	10.8%	9.6%	
	Total	36	37	73	
		100.0%	100.0%	100.0%	
Overweight	Excellent	11	1	12	0.0001
		61.1%	7.1%	37.5%	
	Good	5	0	5	
		27.8%	0.0%	15.6%	
	Fair	2	13	15	
		11.1%	92.9%	46.9%	
	Total	18	14	32	
		100.0%	100.0%	100.0%	
Obese	Fair	1	2	3	1.000
		33.3%	33.3%	33.3%	
	Poor	2	4	6	
		66.7%	66.7%	66.7%	
	Total	3	6	9	
		100.0%	100.0%	100.0%	

Table-10: Stratification of functional outcome between groups with respect to type of fracture

Type of fracture	**Functional outcome**	**Groups**		**Total**	**p-value**
		Tension band wiring	Malleolar screw		
Type-III	Excellent	20	10	30	0.010
		76.9%	41.7%	60.0%	
	Good	6	6	12	
		23.1%	25.0%	24.0%	
	Fair	0	7	7	
		0.0%	29.2%	14.0%	
	Poor	0	1	1	
		0.0%	4.2%	2.0%	
	Total	26	24	50	

		100.0%	100.0%	100.0%	
Type-IV	Excellent	18	12	30	0.330
		58.1%	36.4%	46.9%	
	Good	5	6	11	
		16.1%	18.2%	17.2%	
	Fair	6	12	18	
		19.4%	36.4%	28.1%	
	Poor	2	3	5	
		6.5%	9.1%	7.8%	
	Total	31	33	64	
		100.0%	100.0%	100.0%	

DISCUSSION

The ankle is a composite joint. It consists of two dissimilar articulations: syndesmosis connecting the distal end of crural bones and diarthrosis between their ends and talus. The ankle is a mortise in which the talus is constrained by the fibula laterally and tibia both superiorly and medially, this configuration as also been referred to as the malleolar fork.[22] The ankle and foot segments provide a stable but mobile support needed to maintain an upright posture. The movement at subtalar joint and ankle joint are usually supportive to each other. Normal motion of the ankle joint is predominantly in the sagittal plane, but it involves variable degrees of rotation around the vertical and longitudinal axes. Inman described the empirical axis of the ankle joint as passing approximately 5 mm distal to the tip of the medial malleolus and 3 mm distal and 8 mm anterior to the lateral malleolus.[23]

The empirical axis of ankle joint is also described as the one passing just below the tips of the medial and lateral malleolus. Because of the variable contours of the medial and lateral talar dome trochlea, ankle joint has a continuously changing axis of rotation.[87] The major weight-bearing surface of ankle is the tibia - talar surface. One sixth of static load of the body weight is transferred through fibula. The fit of talus in mortise in precise, making it the most congruent of the weight bearing joints.

This loading actually serves as a stabilizing influence on the joint because it causes the talus to seek an anatomically reduced position underneath the tibial plafond (by means of an associated 2 mm lateral talar shift). The contributions of the articular surfaces, the ligaments, and the capsular and musculotendinous structures, to the stability and function of the ankle are influenced by changes in loading characteristics and joint position and are altered in response to injury. The ankle fractures occur as a result of strong rotational or predominantly axial Loading. The malleolar fractures are caused predominantly by rotational forces whereas axial loading causes tibial plafond fractures, predominantly. The malleolar fractures primarily involve lateral or medial malleolus and often other parts of the ankle as well. Sharing and tensile forces apposed through the talus produce them indirectly.

Most malleolar fractures occur when the part, including the talus, is fixed on the ground by the body's weight. The type of malleolar fracture that occur depends on two factors: the position of the foot at the time of injury, either supination or pronation, and the *deforming force,* which are external rotation, abduction or adduction.
A relative bending moment is produced with rotation either in the coronal plane, producing talar adduction or abduction relative to tibia, or transverse plane, causing relative internal rotation of the tibia on the talus. These injuries are referred to as external rotation injuries.

The initial position of the foot is important because it determines which structures are tight and therefore are most likely to be injured first. When the foot is pronated, the deltoid ligament is tense, and the initial injury is medial, either a medial malleolar fracture or a deltoid ligament disruption.
The structures that are damaged are, in order, the anterior tibiofibular ligament (stage 1), the lateral malleolus (stage 2), the posterolateral aspect of the capsule or the posterior malleolus (stage 3), and the medial malleolus or the deltoid ligament (stage 4). A fracture of the posterior malleolus can occur in association with either external rotation or abduction injuries of the ankle.
A classification system is useful only if it assists in the selection of the appropriate management, offers a prognosis of eventual outcome, or allows comparison of the results of treating similar injuries. Several different classification systems of ankle injuries exists, but those in current use are Anatomical types, Lauge – Hansen's system, Danis-Weber system and the AO/ Orthopaedic Trauma Association (AO/OTA) system. In the present study, Danis-Weber system classification system was used for operative evaluation. Burwell and Charnley showed that anatomical reduction and rigid fixation led to early return to function. The results in current study were compared with that of Burnwell & Charnley.[24] Gregory Joy et al[25] study recommended that anatomical reduction is the key towards a good clinical outcome, our study is also in contention with the same.
Most authors have stated that anatomical reduction of displaced medial malleolus ensures correction of talar displacement and is of paramount importance in treating unstable fractures.[90] However, Heller et al[91] states that talus is more accurately repositioned in mortise by anatomical reduction of lateral malleolus.
In this study, according to functional outcome, in Malleolar screw group, 22(38.6%) had excellent outcome, while 12(21.1%), 19(33.3%) and 4(7.0%) had good, fair and poor outcomes respectively, while in Tension band wiring group, 38(66.7%) had excellent outcome, while 11(19.3%), 6(10.5%) and 2(3.5%) had good, fair and poor outcomes respectively with a p-value of 0.008, which is statistically significant According to union distribution, 57(100.0%) had union in group-A, while in group-B, 56(98.2%) had union.
In a study, with malleolar screw, 69.23% rated excellent, 16.67% rated good, 10.77% rated fair and 3.33% rated poor, while with tension band wiring, 88.23% rated excellent, 5.67% rated good, 2.1% rated fair and 5% rated poor.[14] In another study, with malleolar screw, 10% rated excellent, 70% rated good, 10% rated fair and 10% rated poor, while with tension band wiring, 20% rated excellent, 70% rated good, 10% rated fair and 0% rated poor.[15] Fracture union was 100% in tension band wiring group and in malleolar screw group was 96.66%.[16]

CONCLUSION

Tension-band wiring more valid option for internal fixation of medial malleolar fractures and more technically advantageous for small fragment fixation of medial malleolar fractures. The tension-band wiring may be more available and its usage could translate into overall cost saving when applied to the large number of ankle

fractures treated surgically.

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PROFORMA

COMPARISON OF OUTCOME OF 4MM CANCELLOUS SCREWS VERSUS TENSION BAND WIRING IN PATIENTS WITH MEDIAL MALLEOLAR FRACTURES

Case No: _____ **Dated:** _____

Name: _____

Address: _____

Gender: ☐ Male ☐ Female

Age: _____ (years), **BMI: _____ (kg/m²)**
Type of fracture: ☐ Type-III ☐ Type-IV

☐ **Group-A** (4mm cancellous screws)
☐ **Group-B** (Tension band wiring)

Olerud & Molander Ankle Score: _____
Functional Outcome: ☐ Poor ☐ Fair
☐ Good ☐ Excellent
Union: Ye☐ No☐

Annexure-I
Olerud & Molander Ankle Score

PARAMETER	DEGREE	SCORE
1. Pain	None	25
	While walking on uneven surface	20
	While walking on even surface outdoors	10
	While walking indoors Constant and severe	5
		0
2. Stiffness	None	10
	Stiffness	0
3. Swelling	None	10
	Only in evenings	5
	Constant	0
4. Stair-climbing	No problems	10
	Impaired	5
	Impossible	0
5. Running	Possible	5
	Impossible	0
6. Jumping	Possible	5
	Impossible	0
7. Squatting	No problems	5
	Impossible	0
8. Supports	None	10
	Taping, Wrapping	5
	Stick or crutch	0
9. Work, activities of daily life	Same as before injury	20
	Loss of tempo	15
	Change to simpler job	15
	Severely impaired work capacity	0

Annexure-II
Lauge-Hansen Classification

Grade	Sequence
Supination-Adduction	1. Talofibular ligament sprain or distal fibular avulsion fracture 2. Vertical medial malleolus fracture and impaction of anteromedial distal tibia

Supination-External rotation	1. Anterior tibiofibular ligament sprain 2. Lateral short oblique fibular fracture (anteroinferior to posterosuperior) 3. Posterior tibiofibular ligament rupture or avulsion of posterior malleolus 4. Medial malleolus transverse fracture or disruption of deltoid ligament
Pronation-Abduction	1. Medial malleolus transverse fracture or disruption of deltoid ligament 2. Anterior tibiofibular ligament sprain 3. Transverse comminuted fracture of the fibula above the level of the syndesmosis
Pronation-External rotation	1. Medial malleolus transverse fracture or disruption of deltoid ligament 2. Anterior tibiofibular ligament disruption 3. Lateral short oblique or spiral fracture of fibula (anterosuperior to posteroinferior) above the level of the joint 4. Posterior tibiofibular ligament rupture or avulsion of posterior malleolus