

Case Series

Bilateral simultaneous rotational ankle fractures: case series and literature review

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ABSTRACT

Bilateral Simultaneous rotational ankle injuries are rare entities with little number of cases reported in literature. Unlike axial type ankle fractures, they tend to happen as a result of pivoting trauma on the supportive limb. We conducted a case series and literature review of patients who presented with simultaneous bilateral ankle injuries and discussed their presentation and imaging. A total of Four cases in our institute and 6 separate cases reported in literature were found who sustained bilateral simultaneous rotational ankle fractures. There were 10 cases, nine of which were simultaneous and symmetrical ankle injuries. Injuries found were; Maisonneuve fracture, Tillaux fracture, Syndesmotic injury, Lauge-Hansen's supination external rotation (SER), pronation external rotation (PER), supination adduction (SAD), and pronation abduction (PA). Four cases were presented in our institute over the last 10 years. A single case was asymmetrical in nature given the presence of an associated distal tibial metaphyseal fracture. Bilateral rotational ankle injuries are rare entity presenting simultaneously unlike axial type ankle fractures. When they present, they are likely caused by higher mechanism of injury than typical unilateral rotational ankle fractures. SER injuries are the most commonly found mechanism in both unilateral and bilateral ankle injuries.

Key words: Bilateral ankle fractures, Bilateral Bimalleolar fracture, Bilateral trimalleolar fracture, Rotational Ankle Injuries

INTRODUCTION

Lauge-Hansen described a classification of ankle fractures that depends on foot position yielding a rotational or translational low energy ankle fractures.¹ It showed great reproducibility and interobserver agreement in a recent report.² While others found some downsides of its use, the classification's most important attribute is that it helps recognizing the mechanism of injury and associated non-osseous injuries that cannot be seen on plain films.¹⁻³ Injury mechanisms commonly reported according to the classification are supination external rotation (SER), pronation external rotation (PER), supination adduction (SAD), and lastly pronation abduction (PA). For instance, SER starts with anterior inferior tibiofibular ligamentous

(AITFL) or boney failure (stage I) followed by a short oblique infrasyndesmotic lateral malleolus fracture or anterior talofibular ligament (ATFL) injury (stage II) followed by posterior inferior tibiofibular ligament (PITFL) or boney failure (stage III) followed by lastly, a medial malleolar or deltoid ligament injury (Stage IV). PER injuries starts with deltoid ligament failure or medial malleolus fractures (stage I) followed by AITFL or boney injury (stage II), then an oblique suprasyndesmotic fibular fracture (stage III), followed by lastly, PITFL or boney injury (stage IV). In SAD ankle injuries, lateral ankle ligaments or distal fibular fracture occur as a result of medial talar translation (stage I), after that, the talus continues to be adducted and tilted causing a vertical medial malleolus fracture with an articular impaction

(stage II). PA injuries start with medial malleolus fracture or deltoid ligament rupture as result of the pronation moment of the talus (stage I), with continued forces, syndesmotoc disruption or posterior malleolus fracture happens (stage II), lastly, a bending force occur as the moment continues on the fibula leading to a transverse or a comminuted suprasyndesmotoc fracture (stage III).^{2,4,5} In axial type ankle injuries such as Pilon and calcaneus fractures, bilaterality has been reported in literature due to the nature of injury mechanism that commonly happens as a result from fall from heights and landing on both

extremities simultaneously.^{6,7} Rotational injuries however tend to happen as a result of sudden catching, twisting or pivoting movement over the supporting leg.^{8,9} Twisting mechanism can lead to multiple variety of injuries such as; Maisonneuve fracture, Tillaux fracture, or Lauge-Hansen classified ankle fractures, all of which have been separately reported in literature to present bilaterally.¹⁰⁻¹⁵ In this study, we present rare cases of simultaneous bilateral rotational ankle fractures and reviewed similar cases presented in literature and discussed the etiological mechanism of the injuries sustained and their presentation.

Table 1: Cases with bilateral simultaneous ankle fractures that have presented to our institute and reported in literature.

Case (year)	Age (years)	Gender	Fracture type	Mechanism of injury	Mechanism severity	Associated injuries/conditions
Case 1	17	Male	SER IV	RTA	High	N/A
Case 2	23	Male	PER IV	Fall down	Low	N/A
Case 3	30	Male	SER IV	RTA	High	distal tibia metaphysis fracture
Case 4	25	Male	right PER IV, left SER IV	Fall from height	High	T12 burst fracture
Case 5 Kang et al ⁹	15	Male	Syndesmotoc injury	Ankle sprain	Low	N/A
Case 6 Dienstknecht et al ¹⁰	72	N/A	Maisonneuve	Syncopal fall	Low	Osteopenia
Case 7 Rosenbaum et al ¹¹	13	Male	Right Tillaux, Left Triplane	Playground gall (5 ft)	Low	N/A
Case 8 Nagasawa et al ¹²	54	Male	SER IV	Fall down	High	N/A
Case 9 Sultan et al ¹³	30	Male	SAD	Object fall while kneeling	High	N/A
Case 10 Atıcı et al ¹⁴	25	Female	PA	MVA	High	N/A

SER= Supination External Rotation, PER= Pronation External Rotation, SAD= Supination Adduction, PA= Pronation Abduction, MVA= Motor Vehicle Accident.

CASE SERIES

A retrospective search in medical records was done looking for bilateral torsional ankle fractures from 2012 to 2022 in King Saud Medical City, which is a community-level I Trauma center in the Riyadh region of the Kingdom of Saudi Arabia. 4 cases were identified, however, only one case had more than a single post-operative follow-up visits. Therefore, approval from the institutional review board (IRB) at King Saud Medical City was obtained in order to describe these cases and their injury characteristics. Patients' ages ranged between 17-30 years old and were medically free. Post operative protocol is generally non-weight bearing immobilization of the injured extremities post-operatively in our institute. Data collected were demographics of the patients, mechanism of injury, available imaging studies including plain radiographs at time of injury, and post-operatively. Literature review

performed was done using; Pubmed, EMBASE and Google Scholar databases with the following search keywords: Bilateral ankle fractures, bilateral malleolar ankle fractures, bilateral trimalleolar ankle fractures, bilateral syndesmotoc injury, bilateral Maisonneuve fracture, bilateral ankle sprain, bilateral transitional ankle injury, bilateral Tillaux fractures. Articles included were the ones that involved cases with bilateral torsional ankle injuries with documented imaging studies. A total of 6 studies were included that meet our inclusion criteria (Table 1). All articles were full and were published in English except for one, which was in Turkish, it was included however given an available English abstract stating the injury mechanism. This study is aimed to highlight an interesting yet rare injury entity that could possibly present and discuss the etiological factors that lead to this presentation. The first case presented to our institute was a 17-year-old male, presented to the emergency department following a head-on motor vehicle accident

(MVA). The patient was a front-seat passenger, restrained, and the injury was anticipated prior to impact which led him to place both his knees in extension with feet implanted against the car floor. Bilateral ankle injuries were identified in isolation, and was confirmed with X-rays and Computed Tomography (CT). the injury was consistent with a bilateral SER IV. Surgical fixation was done at 2 weeks post-injury as there were significant swelling in both lower limbs. According to the operative report, external rotation stress radiographs showed syndesmotic instability, therefore, bilateral syndesmotic fixation was favored by the treating surgeon since the posterior malleolar pieces were small to be captured by a fixation device (Figure 1).



Figure 1: Case 1 Anteroposterior pre-operative; A) and Post-operative, B) X-rays showing bilateral SER IV ankle injuries.



Figure 2: Case 2 Anteroposterior pre-operative; A) and Post-operative, B) X-rays showing bilateral PER IV ankle injuries.

The second case was a 23-year-old male, medically free, presented to our hospital as a case of a motorcycle accident in the desert. The injury was sustained as a result of falling from the bike landing on both feet which were stuck in the sand causing severe pain. Unstable bilateral ankle injuries were identified in isolation, and was confirmed with X-rays and stress imaging. radiographs revealed that he had bilateral identical bimalleolar equivalent injuries evident with significant medial clear space widening on external rotation stress imaging consistent with PER IV. Surgery was delayed until soft tissue swelling allowed at 10 days post-operatively. The patient underwent bilateral open

reduction and internal fixation of both fibulae using Plates and screws, and following external rotation stress radiographs, syndesmotic widening were evident in both sides and the decision was made to proceed with syndesmotic fixation (Figure 2). The third case was a 30-year-old male, presented with a history of MVA. The patient was the driver with an unknown mechanism of injury. He sustained isolated bilateral lower limb injuries. Imaging revealed that he had right open distal tibia metaphyseal fracture with and associated bimalleolar ankle fracture. The injuries sustained to both ankles are asymmetrical unlike other cases since on the right, he has a Weber C fracture while on the left, he has a Weber B fracture. The patient was booked urgently for irrigation, debridement, and external fixation of the open fracture. Later, he was scheduled to undergo bimalleolar ankle fracture fixation using fully-threaded cannulated medial-sided screws and a laterally based plate, for the distal tibia, fixation was achieved using an antegrade intramedullary nail (Figure 3).

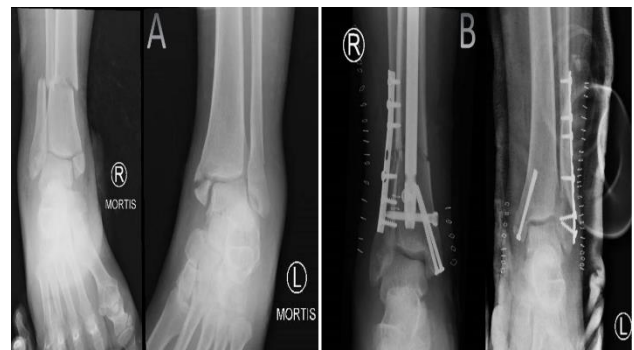


Figure 3: Case 3 Anteroposterior pre-operative; A) and Post-operative, B) X-rays showing a left sided SER IV, and a right sided PER IV with an associated distal tibial metaphyseal fracture.



Figure 4: Case 4 Anteroposterior pre-operative; A) and Post-operative, B) X-rays showing bilateral SER IV ankle injuries.

The fourth case was a 25-year-old female, medically free presented to our hospital as a case of fall from height (9 meters). She was complaining of lower back pain and bilateral ankle pain. Trauma workup revealed that she has a T12 Burst fracture and bilateral symmetrical SER IV.

Surgical management of the spine injury was done followed by both ankle fractures. Surgical fixation of the ankle was achieved using partially threaded cannulated screws of the medial malleolus and plate fixation of both lateral malleoli, no syndesmotic instability was observed according to operative reports (Figure 4). Cases 2,5,6,7 were associated with a low mechanism injury while cases 1,3,4,8,9,10 were associated with a high mechanism of injury. Cases 1 through 8 are associated with external rotational ankle injuries. SER is the most commonly observed pattern in the cases included in the study. Details of cases reported in literature are displayed in (Table 1).

DISCUSSION

Rotational moment is an essential part in low mechanism injury ankle fractures. They tend to happen as a result of pivoting force on the supported leg while the contralateral limb is off the ground or bearing less weight.^{8,9} Having bilateral similar moments simultaneously is an extremely rare sequence of an injury leading to bilateral ankle fractures. Dhillon et al explained that in relation to bilateral quadriceps tendon injuries, they tend to be asymmetrical due to the uneven load shift on the limbs.¹⁶ There were only 6 separate cases reported in literature that are similar to our cases in being bilateral rotational type ankle injuries with some of them being identical.¹⁰⁻¹⁵ Majority of the cases along with ours, were in fact as a result of relatively high mechanism trauma and were associated with rotational injury patterns. This is unexpected especially when the energy absorbed caused symmetrical rotational injuries in contrast to axial type ankle fractures that commonly present as a result of high mechanism trauma.

Supination external rotation ankle injuries are known to be the most common fracture subtype according to Lauge-Hansen classification.^{14,17} We found that they are the most commonly reported rotational ankle injuries in literature along with our cases (1,4).¹³ Nagasawa et al reported a similar presentation to our case 2 in terms of mechanism of injury, however, their patient sustained a SER IV instead.¹³ It is originally described that SER IV and PER IV are different from each other in terms of level of fractured fibula being low in SER and higher in PER.¹⁻³ Haraguchi et al found in their biomechanical study that low fibular fracture can be found in reproduced PER mechanism on cadavers.¹⁸ This could explain the fracture in Case 4 since in the left side, the fibular fracture is low, while high on the contralateral side. We believe that due to the high mechanism of injury the patient sustained a right PER and a left SER.

Pronation external rotation or supination external rotation injuries are believed to be causing Maisonneuve fracture except that a classical Maisonneuve injury is a deltoid ligament injury with an associated syndesmotic and proximal fibular fracture.² Similarly, syndesmotic injury also known as high ankle sprain is known to be caused by External rotation moment of the dorsiflexed foot.²⁰ Dienstknecht et al reported a case in which a bilateral

Maisonneuve fracture was sustained in an elderly patient by a low mechanism fall.¹¹ Kang et al reported a unique subacute case of a bilateral syndesmotic ankle injury in an athlete.¹² Rosenbaum et al reported a unique presentation of a child with a bilateral distal tibial transitional fracture as a result of fall from height.¹⁴ These injuries are considered an analogue to Lauge-Hansen's SER in terms of mechanism of injury that is supination external rotation, but due to physeal presence and its closure pattern, they tend to present as a Tillaux or triplane fractures.²¹ Associated syndesmotic injury in SER IV is uncommon. It has also been reported that functional outcomes did not differ with fixation of unstable syndesmosis compared to another similar group who had no fixation.^{3,22} In our institute, the common practice is fixation of syndesmosis when there is a suspicion of injury pre-operatively by way of manual external rotation stress testing or intra-operatively by doing Cotton's test. Internal or external rotation associated ankle injuries are more common than abduction and adduction ankle injuries classified according to Lauge-Hansen classification.^{4,17} There were only 2 cases reported in literature that were associated with bilateral adduction or abduction moment.^{10,15} Sultan et al reported a uniquely presented bilateral symmetrical supination adduction fracture dislocation as a result of a tree log falling over the patient's legs while working.¹⁵ They highlighted an important aspect in this case that is feet position at time of injury being an important aspect leading to this presentation. Supination Adduction injury is regarded by some authors as a Pilon variant given the articular impaction caused by the associated axial load moment along with the relatively higher rate of cases undergoing arthrodesis compared to other rotational ankle injuries.²³ Another case reported by Atıcı et al of a pregnant lady who sustained what it seems a bilateral pronation abduction ankle fracture dislocation.¹⁰ From the abstract, it is stated that she sustained a motor vehicle accident and the given images on the full text, it fits LH PA II injury since she had comminuted fibular fractures and transverse medial malleolar fractures with an abducted talus.

CONCLUSION

Bilateral simultaneous rotational ankle injuries are extremely rare. Their presentation has been reported in literature but in few cases. Although low mechanism rotational ankle fractures tend to present following a twisting moment on the supporting leg, they can possibly however present in bilateral lower limbs but due to a greater degree of injury mechanism severity. SER type is the most common reported mechanism of injury of cases presenting with bilateral rotational ankle fractures along with ours. Careful assessment following trauma is essential in order to avoid missing any other injuries.

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