Original article:

The frequency of proximal tibiofibular joint types in patients with malleolar fractures

Ghaffari S[1], Azar MS[2], Kariminasab MH[3], Ranjbar T[4], Ghaffari B[5]

Abstract

Background: Due to the prevalence of ankle malleolar fractures and by considering the influence of proximal tibiofibular joint(PTFJ) on fibula movement during ankle motion and subsequently on ankle injuries, this research was conducted to determine distributed frequency of the PTFJ in adult patients with malleolar fractures. ***Methods:*** This survey was conducted on a prospective cross-sectional basis. adult patients with malleolar fractures in two year period enrolled . Information, such as gender, age, mechanisms of fractures, reason of fractures, location of fractures was Collected, classified and reported along with descriptive statistics. Frequency of PTFJ in normal population determined and used for comparison with study group. ***Results:*** In the 79 patients could match our criteria in this study. The age of patients was 37±15 with range of 18-80 years. The highest number of ankle fractures were seen in third decade of age and these fractures were more prevalent in men. The most common cause of ankle fractures was traffic accidents (54/43%).the most common injury was lateral malleolar fracture (68/74%) and the most common mechanism of injury was Lauge-Hansen supination – external rotation, Danis-Weber type B . Frequency of PTFJ transverse and oblique types in normal population (80.6/19.4%)and study(71/29%) groups was statistically different (P < 0/05). According to mechanism of injury and location of fibular fracture, there was no significant difference between PTFJ types (P > 0/05). ***Conclusions*:** Frequency of oblique PTFJ in patients with malleolar fracture was more than normal population. There was no correlation between PTFJ type and mechanism of malleolar fracture or location of fibular fracture.

Keywords: ankle malleolar fracture; Proximal Tibiofibular Joint; Danis-Weber; Lauge-Hansen

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Introduction

The anatomy, clinical and functional importance of the proximal tibiofibular joint (PTFJ) seems to be neglected in the literature. Some articles explore the anatomy and physiology of this joint more deeply, stressing its biomechanical aspects in weight bearing[1] and in relation to ankle motion[2]. The proximal fibula, serving as the point of insertion of the biceps femoris ,fibular collateral ligament ,fabellofibular ligament and popliteofibular ligament must play an integral role in knee lateral stabilisation, and dislocation of the proximal fibula may compromise knee lateral stability[3]. The tibia and fibula move relative to each other in three regions—the proximal tibiofibular articulation, the interosseous membrane and the distal tibiofibular syndesmosis[4]. Movement is slight at the PTFJ, but it imparts some flexibility during ankle movement and in response to the action of the muscles attached to the fibula[5]. The fluoroscopic studies of Ogden[6] showed that with dorsiflexion of

1. Salman Ghaffari, Assistant professor of orthopedic surgery, Orthopedic Research center, Mazandaran University of Medical Science, Sari, Iran.
2. Masoud Shayesteh Azar, Associate Professor of Orthopedic Surgery, Orthopedic Research Center, Mazandaran, University of Medical Science, Sari, Iran.
3. Mohammad Hossein Kariminasab, Associate Professor of Orthopedic Surgery, Orthopedic Research center, Mazandaran University of Medical Science, Sari, Iran.
4. Tahereh Ranjbar , Student Research Committee, Mazandaran University of Medical Science.
5. Bahman Ghaffari, Medical Student, Mazandran International University, Mazandaran, Iran.

Correspondence to: Masoud Shayesteh Azar, Associate Professor of Orthopedic Surgery, Orthopedic Research Center, Mazandaran University of Medical Science, Sari, I.R.Iran.E-mail: mshayestehazar@yahoo.com

the ankle, the proximal fibula rotated a few degrees, this rotation being more evident in the horizontal than the oblique PTFJ. The anatomy of the PTFJ is related to its ability to withstand forces applied axially[7]. While one of the functions of the PTFJ appears to be dissipation of torsional loading applied at the ankle joint, felt that the fibula also had a weight-bearing function, with approximately one-sixth of the static load applied at the ankle being transmitted to the PTFJ. This force was generated by the fibula's articulation with the talus and possibly also by the inferior tibiofibular ligaments and was transmitted to the PTFJ[8].

Ankle anatomy holds the key to understanding fracture patterns and their appropriate treatment. Inman[9] has described ankle anatomy and motion in a classic work. The talus is not flat but rather has a dual-dome upper surface. These two shallow convex curves articulate with a matching tibia distal joint surface. The talus is asymmetric; it is wider anteriorly and has different articulating surfaces with the tibia and the fibula. The distal tibia also narrows posteriorly, and the posterior malleolus does articulate with the talus and its trigonal process. The lateral and medial malleoli provide stability, which is important for both tilt and rotation, and their articulation with the talus constitutes an important amount of joint surface area.

Threeclassificationsystemsdeservemention:[10]Lauge-Hansen,[11]Danis–Weber, and [15] Arbeitsgemeinschaft fu¨ r Osteosynthesefragen–Orthopaedic Trauma Association (AO–OTA) classification (Figure 1). For any classification system to be useful it must be reproducible and either guide treatment or effect prognosis or both. Unfortunately, the current ankle fracture classification systems fail to adequately fulfill these criteria. However, they can be helpful in understanding the mechanism of injury, methods to obtain reduction, and some aspects of treatment. The Lauge-Hansen system arose from the clinical, experimental, and radiographic observations of the author[12]. This system is based on the position of the foot (supination or pronation) and the deforming forces (external rotation, abduction, or adduction). The author found four primary injury mechanisms (he later added a fifth to cover axially loading injuries[13] and correlated radiographic appearance with these injury patterns. He found each of the patterns occurred in a predictable sequence based on the severity of the injury. In reality, however, all fractures do not easily conform to one of the patterns. Interobserver reliability has been found to be poor[11]. This system is helpful because it mechanistically explains the pattern of injuries seen and seems to help in understanding reduction maneuvers as well.

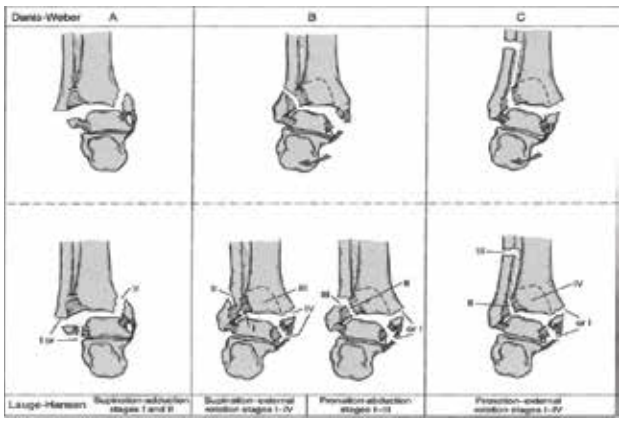

Figure 1. Ankle fracture classification systems.

The Danis–Weber classification system is based upon the level of the fibula fracture[14]. Type A" injuries occur below the level of the syndesmosis. Type "B" injuries occur at or near the level of the syndesmosis. Type "C" injuries include a fibula fracture above the level of the syndesmosis. The weaknesses of this system are poor interobserver reliability[10], lack of information regarding injury to the medial side of the ankle, and inability to reliably predict prognosis. Weber C fractures usually require operative intervention; the degree of intervention remains controversial. An exception is the clinical finding that type A fractures do well nonoperatively[15] A third system, published by the Orthopaedic Trauma Association, is essentially a more detailed Danis–Weber system that adds degree of comminution and injury to the medial side and the posterior ankle[16]. Reliability, use in treatment, and its correlation with prognosis are yet to be determined.

The classification and stage division of malleolar fractures by Lauge Hansen has been recommended by several authors[8]. This system was further developed by Lauge Hansen on the basis of dissection findings after experimentally produced fractures and by means of combined clinical and roentgenological examinations[17]. He established the following groups of ankle fractures: supination-adduction(SA), supination-eversion(SER), pronation-abduction(PA), pronation-eversion(PER) and pronation-dorsiflexion(PD). Depending on the degree of severity the main groups can be further divided into stages[18]. The Danis-Weber classification is based on the location and appearance of the fibular fracture. A type A fracture is a transverse fracture of the lateral malleolus at or below the plafond ,

type B fracture is an oblique fracture of the lateral malleolus,beginning on the anteromedial surface and extending proximally to the posterolateral aspect, Type C fractures are oblique fracture of the fibula proximal to the disrupted tibiofibular ligaments (C-1) and more proximal fracture of the fibula and more extensive disruption of the interosseous membrane (C-2).Over the past 20 years an increasing number of reports of operative treatment of ankle fractures have appeared. Thus the understanding of ankle fractures and the recognition of all associated injuries has become more important[19]. The purpose of this paper is to evaluate the frequency of Proximal Tibiofibular Joints in adult patients with malleolar.

Materials and Methods

This study was performed on adult patients with malleolar fractures in Imam Khomeini and Bu Ali Sina hospitals of Sari in the period January 2015 to December 2016. High energy Pilon fractures were excluded. Study was approved in Orthopaedic Research Center, Mazandaran University of Medical Sciences. To all the patients were full knowledge, and participation in the study was taken. However intervention was not performed in addition to conventional diagnostic methods because knee radiographs in the form of Standard should be done in patients with ankle fractures. Patients who had inclusion criteria entered to Study, and patients' data, including age, gender, height, weight, body mass index, mechanism of injury, type of injury and location of malleolar fractures were recorded. Data was obtained based on clinical examination, imaging studies and intraoperative findings. Cause of injury, including traffic accidents, falling from height, simple falling , sports and other occasions recorded. location of injury including medial malleolar fracture, lateral malleolar fracture, posterior malleolar fracture, syndesmosis damage, deltoid ligament injury, lateral ligament injury identified. Location of Lateral malleolar fracture according to Danis-Weber classification, below syndesmosis, syndesmosis level, above syndesmosis and fibular neck was recorded. Mechanism of malleolar fracture according to Lauge-Hansen classification was determined. Frequency of proximal tibiofibular joint in the community was determined by radiographic evaluation of individuals who came in the same period for a non-malleolar fractures or lateral knee pain but had knee radiography.

To measure the PTFJ angle, in lateral knee radiography, a line along the longitudinal axis of tibial and a second line along the articular surface of proximal fibula was drown. Finally angle between the line perpendicular to the axis of the tibia with the line along the articular surface of fibula was measured[19].

Figure 2. How to measure horizontal and oblique proximal tibiofibular joint

PTFJ then classified in two groups; transverse type with the angle less than twenty degrees and oblique type with more than twenty degrees. Two orthopedic surgeons did measurement of PTFJ separately and in cases of difference the mean value of them was used. Frequency of the type of malleolar fractures was determined. Frequency of the fractures types, according to factors such as gender, height, weight and body mass index was also determined.

Frequency of PTFJ in ankle malleolar fracture group (study group) and in normal population (control group) was compared.

Frequency of PTFJ types in the study group was determined according to Danis-Weber and Lauge-Hansen mechanism of injury.

For comparison and statistical analysis qualified data of the square test and for quantitative data from normal distribution was performed. In all tests the significance level of $\alpha = 0.05$ was considered significant. Collected data were analyzed by using SPSS version 18.

Results

Frequency of proximal tibiofibular joint types were measured in normal peoples of both sexes.in the two years period of this study 242 normal individuals were evaluated, 185 male (144 horizontal and 41oblique) and 57 women (51 horizontal and 6 oblique). Overall 195/242(8o.58%) PTFJs were transverse type and 47/242(19.42%) were oblique type in normal population (control group) (Table 1).

In the two years period of this study 79 adult patients with mean age of 37+/_15(18-80)years with malleolar fractures (study group) were admitted and

evaluated. 62 male and 17 female with 44/18 and 12/5 transverse/oblique types of PTFJ respectively. Overall 56/79(70.89%) PTFJs were transverse type and 23/79(29.11%) were oblique type in patients with malleolar fractures (Table 1).

Table 1. Prevalence of proximal tibiofibular joint types in normal and patients population

Status of individual		proximal tibiofibular joint types
normal	Patient	
47/242(19.42%)	23/79(29.11%)	oblique
195/242(8o.58%)	56/79(70.89%)	transverse

Difference in frequency of proximal tibiofibular joint in normal and patients individuals with malleolar fractures through the F test are meaningful, level of significance was estimated to be also acceptable (P<0/05).

PTFJ angle in study group was 0-36 degrees with the mean angle of 14.78+/_9.PTFJ angle in normal population control group was 0-65 degrees with the mean angle of 11.67+/_12.5.

The most common cause of malleolar fractures was traffic accident (43/79,54.43%). other causes included simple fall (14/79,17.73%), sport (6/79,7.59%),fall from height(6/79,7.59%) and other miscellaneous injuries(10/79,12.66%) (Table 2).

Table 2. frequency and causes of injuries

Frequeny	Cause of Malleolar Fractures
43/79(54.43%)	*Traffic Accident*
14/79(17.73%)	*Simple Fall*
6/79(7.59%)	*Sport*
6/79(7/59%)	*Fall from Height*
10/79(12.66%)	*Other Miscellaneous Injuries*

According to Lauge-Hansen mechanism of injury, the most common was supination-external rotation (SER,48/79,60.75%) then pronation-ab duction(PA,12/79,15.19%),pronation-external rotation(PER,10/79,12,66%) and supination-adduction(SA,9/79,11.40%) respectively. The frequency of transverse/oblique types of PTFJ in SER, SA, PER and PA groups was 33/15(68.75/31.25%),6/3(66.66/33.34%),7/3(70/30%) and 10/2(83.33/16.67%) respectively. There was no significant difference in frequency types of PTFJ according to Lauge-Hansen mechanism of injury (p value >0.05).

Table 3. Frequency of proximal tibiofibular joint types in patients with malleolar fractures based on mechanism of injury

Frequeny	proximal tibiofibular joint types	According to Laug-Hansen mechanism of injury
33/15(68.75/31.25%)	*horizontal*	SER
22/34(45/35%)	*oblique*	
6/3 (10/65%)	*horizontal*	SA
1/99(20/66%)	*oblique*	
7/3 (11/65%)	*horizontal*	PER
41/23(70/30%)	*oblique*	
10/2 (61/54%)	*horizontal*	PA
4/99(71/33%)	*oblique*	

Lateral malleolar fracture according to Danis-Weber classification determined., below syndesmosis (type A), at the syndesmosis level (type B) and above the syndesmosis (type C). the frequency of transverse/ oblique types of A, B, C was 20/5 (25.31/6.32%) , 27/12(34.17/15.18%) and 9/4 (11.39/5.06%) respectively. B type was the most common and the least was type C. no statistically significant difference was between the location of fracture and the frequency of horizontal and oblique PTFJ (P>0/05).

Table 4. Frequency of proximal tibiofibular joint horizontal and inclined in place malleolar lateral Fracture

Frequency	proximal tibiofibular joint types	Syndesmosis Classification
20(25.31%)	transverse	A
5(6.32%)	oblique	
27(34.17%)	transverse	B
12(15.18%)	oblique	
9 (11.39%)	transverse	C
4 (5.06%)	oblique	

Type of ankle injury was determined: The frequency of transverse/oblique types of Medial malleolar fracture (MMF), lateral malleolar fracture (LMF), Posterior malleolar fracture (PMF), syndesmosis damage (SD), Deltoid ligament damage (DLD), lateral ligament injury (LLI) was 28/14 (35.44/17.72%), 44/15 (55.69/18.98%), 6/2 (7.59/2.53%), 12/9 (15.18/11.39%), 11/2 (13.92/2.53%) and 3/1 (3.79/1.26%) respectively. Accordingly, the most common injury was lateral malleolar fracture and

the least was lateral ligament injury. There was no significant relationship between the type of injury and the frequency of PTFJ (P>0/05).

Table 5. Frequency of proximal tibiofibular joint in ankle injury, based on the Type of damage

Frequency	proximal tibiofibular joint types	Types of ankle injury
28 (35.44%)	transverse	MMF
14 (17.72%)	oblique	
44 (55.69%)	transverse	LMF
15 (18.98%)	oblique	
6 (7.59%)	transverse	PMF
2 (2.53%)	oblique	
12 (15.18%)	transverse	SD
9 (11.39%)	oblique	
11(13.92%)	transverse	DLD
2 (2.53%)	oblique	
3 (3.79%)	transverse	LLI
1 (1.26%)	oblique	

MMF= Medial malleolar fracture, LMF= lateral malleolar fracture, PMF= Posterior malleolar fracture, SD=syndesmosis damage, DLD= Deltoid ligament damage, LLI= lateral ligament injury.

Conclusion and Discussion

The principal aim of this study was to determine the frequency of proximal tibiofibular joint types in adult patients with malleolar fractures. To our knowledge there is no similar clinical study to evaluate the frequency of PTFJ in ankle malleolar fracture. Determining this frequency can help to identify the role of PTFJ in fibula and ankle moion.the range of ankle and the range of fibular motion during ankle motion can influence the resulting injury pattern. This study provided the following new insights. First, the frequency of oblique PTFJ in adult patients with malleolar fractures was more common than normal population. This finding confirms the biomechanical studies' result that proved less motion in oblique PTFJ[12]. Oblique PTFJ with less fibular motion during ankle loading may predispose the patient to malleolar fractures. Second, there was no significant difference in the frequency of PTFJ types according to Lauge-Hansen mechanism of injury and Danis-Weber location of fibular fracture[2]. This means that oblique PTFJ predisposes to ankle fracture but can not predict type of ankle malleolar fractures. In general, it seems that the frequency of proximal tibiofibular joint types in patients with malleolar fractures is different from existing statistics research. Therefore, malleolar fractures involvement of the PTFJ joint may not be such a rare finding of peripheral involvement.

Limitations

In this study were studied small number of the patients and is needed study of more extensive to be conducted in this field.

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