Validation of the Classification of Leonetti and Tigani in Tibial Pilon Fractures Through Resident Doctors in Traumatology and Orthopedics and Foot and Ankle Fellows

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ABSTRACT

Objective: To validate the classification of Leonetti and Tigani with evaluators of different levels of expertise. **Materials and Methods:** 54 patients with 54 tibial pilon fractures were evaluated retrospectively. Patients were studied using AP and lateral radiography of the distal tibia, as well as CT scans (axial, coronal, and sagittal images with reconstruction). All subtypes of the Leonetti classification were included. The evaluators presented different levels of training: two Foot and Ankle fellows and two residents in their last year of training. To determine the interobserver agreement, each case was classified into types I, II, III and IV according to Leonetti. To determine the intraobserver agreement, the cases were analyzed by the same evaluator after 6 weeks. The kappa coefficient (k) was used to determine the degree of agreement between the evaluators, that value was expressed with a 95% confidence interval. **Results:** The intraobserver agreement between the first and second evaluation for fellows was moderate and very good. For the residents, it was good and very good. The interobserver agreement for the classification of tibial pilon fractures presented an overall kappa of 0.7156 (95%CI:0.60 to 0.83), which is a good value when all fractures are considered by all evaluators. **Conclusion:** This tibial pilon fracture classification system surpasses previous studies of other classifications in terms of agreement. These agreements were reached with physicians with varying levels of expertise. Our findings contribute to the external and independent validation of this new classification system.

Keywords: Tibial pilon fractures; tomographic classification; interobserver agreement.
Level of Evidence: IV

Clasificación de Leonetti y Tigani para fracturas del pilón tibial: validación con residentes de Traumatología y Ortopedia, y fellows en tobillo y pie

RESUMEN

Objetivo: Validar la clasificación de Leonetti y Tigani con evaluadores de diferentes niveles de experiencia. **Materiales y Métodos:** Se evaluó a 54 pacientes (54 fracturas del pilón tibial) en forma retrospectiva. Se tomaron radiografías de tibia distal, de frente y perfil, y una tomografía computarizada con cortes axiales, sagitales, coronales y reconstrucción 3D. Se incluyeron todos los subtipos de la clasificación de Leonetti y Tigani. Los evaluadores tenían diferentes niveles de entrenamientos: dos eran *fellows* en pie y tobillo, y dos, residentes del último año de formación. Para determinar la concordancia interobservador, cada caso fue clasificado en tipo I, II, III o IV, según Leonetti y Tigani. Para evaluar la concordancia intraobservador el mismo evaluador analizó los casos a las 6 semanas. Se utilizó el coeficiente kappa para determinar el grado de concordancia entre evaluadores y ese valor fue expresado con un intervalo de confianza del 95%. **Resultados:** La concordancia intraobservador fue moderada y muy buena para cada *fellow*, y buena y muy buena para los residentes, entre la primera y segunda evaluación. La concordancia interobservador arrojó un coeficiente kappa global de 0,7156 (IC95% 0,60-0,83), un valor bueno cuando se consideraron todas las fracturas por todos los evaluadores. **Conclusiones:** El sistema de clasificación de fracturas del pilón tibial alcanza concordancias superiores a las de estudios previos de otras clasificaciones. Dichas concordancias se lograron con médicos con diferentes niveles de experiencia y conocimiento. Nuestros hallazgos contribuyen a la validación externa e independiente de este nuevo sistema de clasificación.

Palabras clave: Fracturas del pilón tibial; clasificación tomográfica; acuerdo interobservador.
Nivel de Evidencia: IV

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INTRODUCTION

Tibial plafond or pilon fractures are one of the most complex injuries of the lower limb and represent a challenge for orthopedic surgeons, since their surgical resolution is technically demanding and the rate of sequelae with different disabilities is high. These injuries are generally caused by high-energy trauma.[1,2]

These fractures are characterized by severe metaphyseal joint impaction and comminution and soft tissue involvement. Although the prognosis depends largely on the initial injury, it can be improved with proper management by early stabilization of the fracture through anatomical reduction of the joint and proper alignment.[2]

A classification for tibial plafond fractures should be easy to use, inclusive, reliable and reproducible, should provide a prognosis and assist the surgeon in decision making.

The AO and Ruedi-Allgower classifications are based on radiographs and are simple to understand, but their degree of agreement and reproducibility is moderate.[3,4]

In 2017, Leonetti and Tigani[5] published a new classification system that evaluates the number and displacement of articular fragments, the direction of the major fracture line and comminution. This system had excellent reliability and reproducibility in the original publication. However, there is only one publication that independently validates this classification.[6] We believe that it is important for this classification to be independently validated and that it can be interpreted and understood by physicians of various levels of experience, residents in our specialty, as well as ankle and foot subspecialty fellows, as they are frequently the ones who receive patients with this type of emergency.

The objective of this study was to validate the Leonetti and Tigani classification using evaluators with varying expertise levels.

MATERIALS AND METHODS

Fifty-four patients (54 tibial plafond fractures) were evaluated retrospectively. Inclusion criteria were: patients with tibial plafond fractures and complete studies (AP and lateral distal tibia radiographs, and computed tomography [CT], axial, sagittal and coronal slices with 3D reconstruction). All cases were selected by an author who did not participate in the evaluation. All subtypes of the classification were included.[5] The evaluators had varying levels of training: two ankle and foot fellows and two residents in their final year of residency. Each evaluator received a digital folder with the 54 cases and did not have access to the identity of the patient or the definitive treatment.

To determine interobserver agreement, each case was classified into types I, II, III or IV, according to Leonetti and Tigani. The evaluators had to analyze the number of articular fragments, their displacement, the direction of the main fracture line and the presence of comminution. To determine intraobserver agreement, the same evaluator analyzed the cases after six weeks.

The statistical analysis was performed with Epidat software version 4.2 (2016). The kappa coefficient was used to determine the degree of agreement between the evaluators, expressed with a 95% confidence interval. Agreement was measured for types I, II, II and IV, and for subtypes. Agreement levels (kappa coefficient) were those proposed by Landis and Koch.[7] Table 1 details the interpretation of the kappa coefficient.

Table 1. Interpretation of the kappa coefficient

Kappa coefficient	Agreement strength
<0,20	Poor
0,21-0,40	Weak
0,41-0,60	Moderate
0,61-0,80	Good
0,81-1,00	Very Good

RESULTS

Intraobserver agreement between the first and second assessments was 0.5737, moderate (Fellow 1) and 0.8592, good (Fellow 2); and 0.639, good (Resident 1) and 0.85, very good (Resident 2) (Table 2).

Table 2. Intraobserver agreement (between the first and second assessment)

	Observed agreement	Kappa coefficient	95% confidence interval (kappa)	Statistical significance
Fellow 1*	72.22%	0.5737	[0.3894; 0.7580]	p <0.0001
Fellow 2*	90.74%	0.8592	[0.7418; 0.9767]	p <0.0001
Resident 1	57.41%	0.639	[0.2804; 0.6092]	p <0.0001
Resident 2	87.04%	0.859	[0.7112; 0.9486]	p <0.0001

*Physician attending sub-specialization in ankle and foot.

Interobserver agreement for the classification of tibial plafond fractures yielded an overall kappa coefficient of 0.7156 (95%CI 0.60-0.83) when all fractures were considered by all evaluators. Table 3 shows the interobserver agreement values.

The agreement obtained was 68.52% among ankle and foot fellows, and 74.07% among residents.

Table 3. Interobserver agreement

Type of fracture	Kappa coefficient	95% confidence interval
Type I	0.74	0.68-0.80
Type II	0.88	0.78-0.98
Type III	0.62	0.47-0.77
Type IV	0.65	0.49-0.81
Global kappa	0.71	0.60-0.83

DISCUSSION

There are multiple systems for classifying tibial plafond fractures, the most commonly used are the AO and Ruedi-Allgower classifications. Both are inclusive and easy to apply; however, some studies show certain limitations. These classification systems do not provide accurate information on fracture morphology and have poor to moderate interobserver agreement.[5,8]

The Leonetti and Tigani classification is a simple tool that includes different fracture patterns of the tibial plafond and provides adequate information on fracture morphology based on CT. The use of CT is widely supported in the literature and is used in trauma centers for the management and surgical planning of tibial plafond fractures.[9-11]

This tomographic classification system is based on the number of articular fragments and on the evaluation of the direction of the major sagittal or coronal fracture line.

The overall interobserver kappa coefficient of our study was lower than that of the original publication, 0.88.[5]

There is evidence that independent evaluations of grading systems yield lower levels of agreement[11-13] In our study, the evaluation was performed by ankle and foot fellows and residents in their final year of training; according to the literature, this could lead to lower levels of agreement.[12,14-16]

The AO and Ruedi-Allgower classification systems have had moderate agreement, whereas, in the Leonetti and Tigani classification, the levels of agreement are better: kappa coefficient 0.696 and 0.885, or very good. One of the reasons could be that this new classification is tomographic. However, Ramappa et al.[12] published a moderate intraobserver and interobserver agreement comparing the AO, Ruedi-Allgower and Toplis classifications using CT. Therefore, what would allow a classification to have a better agreement is not the modality of the image, but the simplicity and its easy application.

Intraobserver agreement was good to very good for residents, and moderate to very good for ankle and foot fellows, between the first and second assessments. The residents had better agreement (74.07%) than the two fellows (68.52%) between the first and second assessments.

Interobserver agreement was good (0.71) when all fractures (types I-IV) were considered, but also when subtypes were considered. This could be due to the fact that this system has fewer categories than the rest of the classifications. The greater the number of categories, the greater the information, but the lower the confidence.

CONCLUSIONS

The pilon fracture classification system proposed by Leonetti and Tigani achieves higher agreement levels than those of previous studies of other classifications. These agreements were reached by physicians with different levels of experience and knowledge. Our findings contribute to the external and independent validation of this new classification system.

Conflict of interest: The authors declare no conflicts of interest.

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